ELECTRICAL REVIEW

[ILLUSTRATED.]

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The New England Glass Works.

The New England Glass Works was established in 1817, when the Boston Porcelain and Glass Factory at Lechmere Point was purchased by Edmund Monroe, Denning Jarvis, Daniel Hastings and Amos Binney. Under the new management the business was at once put on a prosperous basis, and rapidly extended. Starting with one small six-foot furnace, with a capacity of 700 pounds to the pot, the works have increased from time to time, so that at present there are employed in all about 300 persons. The rapid growth has been largely due to the superior quality of the goods manufactured. In the first years of the business wood was used for fuel, and when coal was adopted in place of wood chimneys with strong draught had to be built. Each furnace is connected by an underground flue with the great chimney built in the central yard. This chimney, 225 feet in height, is nearly twenty-five feet higher than Bunker Hill Monument, in the neighboring part of Boston, which was formerly Charlestown.

In the manufacture of glass either oxide of lead or lime is used. When the latter is an ingredient, the glass lacks the luster and transparency, so noticeable when oxide of lead is used in its place. No lime is used at the New England Glass Works; and, so careful are they in obtaining a pure quality of lead-oxide, that for many years they made from pig-lead, enough not only for their own use, but to supply others. The pig-lead is placed in large ovens and the heat of the coke fire soon raises the mass to a temperature, when it absorbs the oxygen from the air and is converted into oxide of lead. This process requires about twelve hours, after which it is ground wet and dried.

This company, in the early days of arc-lighting, began the manufacture of glass globes for electric lights, several of which are shown in this issue of the REVIEW, and has, by persistent and costly experiments, held the lead. It has been found that arc-light globes, owing to the severe tests to which they are subjected by exposure to the weather, require the best glass, which must be made of lead. By experiments with this kind of glass a globe has been manufactured in which the percentage of breakage is very small. The globes are all blown by hand, and great attention is paid to the process of annealing. They are placed in an oven kept hot by a flame of burning gas playing on the roof, and are little by little moved to a cooler part of the oven and at last removed. They are toughened by this process, and capable of sustaining great changes of temperature without cracking. The globes are blown of a uniform thickness as thin as it is possible for them to be, while having sufficient strength.

In many places it is desirable to shield the direct rays of the arc light, and for this purpose the glass is placed in an arbor and rapidly revolved, while a wire brush with wet sand is pressed against the surface of the glass. The whole, or any portion of the globe, may be roughened in this way.

While the plain or roughened globe made by this concern are peculiarly adapted for electrical use on account of their evenness and their translucent quality, a new style, called the "frosted," will soon be put upon the market. This new pattern has a marked advantage, as almost no light is cut off by the glass and the diffusive power largely increased. The New England Glass-works' globes are remarkably free from the specks and blotches which are so unsightly when magnified by the intense rays of the arc light.

In view of the keen competition abroad among glass manufacturers, it is at least not unworthy of notice that the finest foreign productions have been surpassed both in novelty and artistic excellence by the "Amberina" and "Pomona" styles of manufactured glass. The former is of a ruby shade merging into an amber tint; in the latter a light amber shade has in most cases a background of frosted glass.

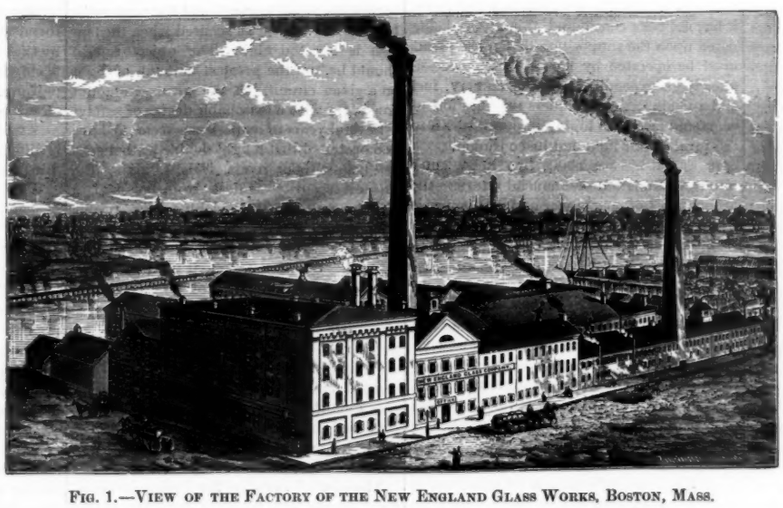


FIG. 1.—VIEW OF THE FACTORY OF THE NEW ENGLAND GLASS WORKS, BOSTON, MASS.

By a recent decision of Judge Colt, in the United States Circuit Court, in the case of Edward D. Libbey *vs.*, The Mount Washington Glass Company *et al.* an injunction was granted to restrain the defendant from infringing letters patent No. 282,002, granted to Joseph Locke, now the property of Edward D. Libbey, proprietor of the New England Glass Works. The patent covers the process of manipulating glassware containing gold ruby in such a way that the two colors of amber and ruby shading into each other are produced.

Shades of great variety in Pomona art glass, which in part have the frosted appearance previously mentioned, are made for incandescent lamps. The variety of effects to be obtained by grouping in various ways the different styles of these artistic shades in incandescent lighting opens up a new field of household ornamentation.

Incandescent lamp-shades of decorated porcelain were seen at the works. The shades are painted inside and outside with the desired pattern and the whole is then fired a second time.

At the recent meeting of the Electric Light Association, in Baltimore samples of incandescent shades of various patterns were shown and greatly admired. A new catalogue containing illustrations of the various globes and shades made at their works, has just been issued. From the excellent variety here shown, a judicious choice can be made to suit any style of furnishings. The growth of the business is keeping pace with the development of electric lighting and bids fair to assume large proportions during the coming season.

For incandescent-lamp bulbs a special quality of glass tubing is made, which fully answers the requirements of clearness, ease in working, and toughness demanded by the conditions of manufacture.

The works, which cover five acres, are situated in East Cambridge, on the line of the Boston and Lowell Railroad.

—— Mr. Otto Fahnehjelm, of Sweden, has invented a combination of a suitable substance and flame for producing light from an incandescent solid. The flame of water-gas has an intense heating power. An ordinary fan-tail burner is used, the flame from which passes between two rows of vertical teeth composed of magnesia, baked and molded, with starch, under high pressure. The teeth when heated become beautifully luminous, and the light shows colors correctly, and can be used for photography.

—— "The use of the electric light in churches," says the *St. James's Gazette*, "will be a great boon to congregations who suffer severely at the evening services from the pollution of atmosphere caused by gas burners. St. George's Church, Hanover square, is now lighted with electricity; and this improvement will, there can be little doubt, before many years have passed, be introduced into many other churches. It is really time that some attention should be bestowed upon not only the lighting, but also the ventilation of churches.

Incandescent Electric Lighting.

As Discussed at the National Convention in Baltimore during the Closing Sessions.

"Operating Expenses" Treated of at Considerable Length.

Friday's Proceedings in Detail.

In our issue of February 20 we published a complete and connected report of the proceedings of the National Electric Light Convention, each day's work appearing in full, with the exception of Friday's, a careful summary of which appeared. We publish below the detailed report of Friday's proceedings which completes the story of the Baltimore convention, with the exception of two or three papers which were read to the convention and which will appear later.

Mr. Van Depoele's paper on 'Electric Motors," was read by the secretary, and received with much applause

Dr. Allen V. Garrett, of the Chemical Electric Light and Power Company, of Boston, gave the association an interesting account of the experiments of his company with a primary battery, as a means of furnishing incandescent light. He said: "I need not tell you, gentlemen, that I have not come here to warn you against forming crude and hastily adopted notions in regard to the electrical system which I represent, for I believe that the electric light companies of this country are represented by men who do not jump hastily at conclusions, and who are not in the habit of taking things for granted; but I ask you in all fairness, not to unthinkingly class one system of lighting with those inventions which periodically appear before the public with meteor-like brilliancy, claiming to do that which every scientist knows to be impossible with the materials at their disposal; companies whose exodus from the business arena is as sudden and, to the uninitiated, as unexpected as their advent, and in regard to whose end we must remain silent if we wish to be charitable.

"Had it not been for the scholarly paper (by Dr. Moses) to which we had the pleasure of listening yesterday morning, I had intended to speak in detail of those early experiments with the Voltaic current; experiments beginning with Professor Volta, of Pavia, in the year 1800, when he constructed his electric pile, followed by his *couronne de tass s*, or crown of cups, which suggested to Sir Humphrey Davy his brilliant experiment of the same year when he dazzled the whole world by producing for the first time the electric arc. These experiments were followed by others so numerous that, were I even to enumerate them, I am sure I should be imposing upon your patience. It is suffi-

cient to say that in the years which followed, a few scientists, conspicuous among whom were Daniell, Grove, Snell, Bunsen and Poggendorf, won for themselves renown which is historic.

"I need not remind you that there are especial points of activity and stagnation in the history of all science, and that at about the middle of the present century, electricians had well nigh abandoned the hope of producing powerful and continuous currents of electricity by the primary batteries, and the attention of electrical investigators was turned more especially to the theory of electro-magnetic induction as advanced by Faraday as early as 1831, after which followed many inventions, conspicuous among which were those of Pixii, Pacinotti, Siemens, Wheatstone and Gramme; and in this way the whole question of producing powerful currents of electricity by purely chemical means fell into background and became looked upon as a thing of the past, and the problem of converting the heat which accompanies the rapid oxidation of fuel into motion, and from motion into electricity, became the absorbing question of the day.

"The latter half of the present decade has, however, marked an epoch of remarkable activity and interest in the subject of producing powerful electric currents by primary batteries and electricians are now working actively on this question.

"In the present state of the art it is not becoming in any man to stand upon the floor of this convention and claim to do with a primary battery that which can be done with a good dynamo machine, but, as you know right well, the question is not always how much electric light can you produce within economic figures, but you are oftentimes asked how little light can you furnish from an isolated plant at a price which consumers will pay.

"This is precisely the question which I am prepared to answer. A primary battery capable of successfully lighting for a number of hundred hours a single incandescent lamp, or, if necessary, a score of them, is not an invention to be put aside as wholly insignificant.

"I speak conservatively when I say that it makes not only possible, but feasible, the electric lighting of a single house, a yacht, a parlor or sleeping car, or even a man's own private carriage. It also places at the disposal of every physician and surgeon a light always ready and requiring but little care, with which he can explore the interior of the human body. I need not suggest other uses for such a light; they suggest themselves to every one. This is a field of electric lighting which is out of the reach of the dynamo machine.

"The Chemical Electric Light and Power Company, of Boston, of which I am the representative, is to-day putting out plants for the purposes which I have enumerated. It controls by letters patent the use in a voltaic battery of those chemicals which alone make possible practical results.

"Heretofore a battery which could maintain an electric light for twenty hours was looked upon as phenomenal. The Chemical Electric Light and Power Company have placed a plant in the New York Mutual Life Insurance Building of Boston, which gives the elevator car three hundred hours of good light, with one charge of battery solution. We are furnishing light at prices which we find the consumers are willing to pay.

"I have intentionally refrained from going into the details of construction of our battery or the composition of our solutions. I should not feel justified in occupying the floor of this convention for any such purpose. I wish simply to say that we have no secrets, and the structure of our battery and the chemicals which we use are at all times open to inspection. The time has gone by for any one to claim to produce electricity or electric light for the public in any way which does not appeal to the good judgment and common sense of practical men who are skilled in this particular branch of applied science.

"I will not longer take your time with this matter. In closing, I wish to say that it has been to me a pleasure to bring before the National Electric Light Association the first practical device for producing the electric light in commercial quantities and within economic figures, by purely chemical means, without the intervention of any mechanical force whatever." (Applause.)

OPERATING EXPENSES.

The first thing after the transaction of the business published in our last, was the presentation of the following paper on "Operating Expenses," prepared by Mr. E. R. Weeks, of Kansas City:

Were it possible to make an estimate of operating expenses, that would be an average for all parts of the country, and for various plants, the result would be of comparatively little value. Conditions are so different that exactly the same plant would require a much larger expenditure in one locality than in another. Water power may be available in one city, and the operating expense of the power department be reduced to an inconsiderable amount. Again, proximity to fuel supplies will give this item a subordinate place. The wide differences in the size of plants do not make a corresponding difference in expenses, even in a given plant, an increase in the number of lamps does not equally affect the expense in all departments, nor is the change in operating expenses in direct ratio to the increase. A plant of incandescent lights does not give the same relative per cent. of expenditure for lamps and for power as obtains in an arc plant; the single item of attendance in the lamp department being much less for the former.

In making an estimate of operating expenses, therefore, it has been thought best to take as a basis, an arc plant of two hundred lamps, and leave as much margin as possible for the varying conditions which affect the cost of labor and supplies

As water power is available in a few cases, it has not been considered, this report being based upon the supposition that most plants must be operated by steam, which necessitates large expenditures for machinery, fuel and attendance, and renders the question of economic measures highly important both to the furnisher of light and its consumer.

In establishing a plant, two items enter into the calculation of financial returns—the original cost of machinery and the expense of running it.

In no other business does so close a relation exist between the quality of machinery, the operating expenses and the net gain. In other industries it pays to buy the best implements; in electric lighting anything else is a loss. Reliability is the first consideration. It is not necessary to say to a body of electric men that stoppage means rebate, rebate means loss, not only in immediate returns, but in confidence from customers, and so greater financial loss.

Every piece of machinery should be chosen not with reference to its price, but to the dependence that can be placed upon its steady, efficient service. The best engine is not good enough. Many a lighting plant has failed because of a poor one. There should be an automatic cut-off, and all bearings should be large and strong. The governor should be perfect so that a change in load shall not result in a change in speed, and a consequent variation in the lights. If given its maximum load, a large engine is much more economical than a number of small ones; but in case of stoppage the loss increases in proportion to the number of lights.

Economy requires a fair grade of oil freely used. Heated bearings result equally from the clogging of poor oil and the stinted use of a good one, and they necessitate stops with a consequent loss of time and its aggravating train of results. The seeming waste from a free use of oil may be prevented by a system of drainage, which will preserve the drip to be used over again, finally to be sold.

Where the water is full of impurities, *special* attention must be given to the construction of the boiler, which should be such as to allow a free circulation, and render all parts easy of access. The *best* boilers require frequent cleanings, with thorough inspection at least once every three months. Heaters should be of such design, grates of suc pattern, and all steam apparatus so set up and adjusted as to allow the use of the lowest grades of fuel in the most economic way. Fuel being a heavy item of expense, an attentive fireman, capable of intelligent judgment as to the greatest amount of heat to be obtained from a given quantity of fuel, is a profitable investment. $3 per day is but value received for the services of such a man. In a two-hundred arc plant he can save more than his salary, and in addition, can produce from a cheap grade of coal better results than can be gained by the ignorant use of the most costly fuel.

As was plainly shown at our last convention, the cost of fuel is a widely varying item, one indeed upon which there seems to be no common ground except the desire to reduce it. According to the varying grades and the different methods of handling, from three to fourteen pounds of coal per lamp per hour are required, and its price ranges from $3.50 to 50 cents per ton.

As the most efficient service demands the closest attention on the part of engineer and fireman, too long a watch should not be required.

Basing our calculations upon a good mixture of slack and nut coal for a two-hundred arc plant at an average distance from the fuel supply, the cost of the power department should be not far from 32 per cent. of the whole operating expense.

Even with the most carefully constructed lines having supports not over 100 feet apart, inspection of the whole circuit should be made every two or three days, especially in cities where there are narrow streets, or a great number of wires. A good line foreman is worth from $15 to $20 per week, and he should keep his department within 7 per cent. of the total operating expenses.

Economy requires an absolutely automatic regulation of the current, and the most satisfactory service will be secured when the tention is not too high. The object sought should be, not the greatest amount of light on a given circuit, but the greatest amount consistent with a reasonable degree of safety.

Several years of experience seem to have demonstrated that a light double-leather endless belt without rivets, is best, giving the greatest security against stoppage and a steadier pull for the machine than results from other kinds of belting. In the care of dynamos, cleanliness cannot be too rigidly exacted. *Clean'iness* here is the watchword not only of success, but of true economy. A neat, rapid and observant attendant is absolutely necessary that trouble and expense may be avoided. To prevent costly delays, all bushings, insulations, etc., should be cleaned daily; frequent inspection of their condition should be made, and they should be found in a state that would leave the white kids of a West Point Inspector, free from the slightest stain.

The cost of running the dynamo department should form about 14 per cent. of the whole operating expense.

Single lamps with larger carbons, even when they must be re-trimmed during service are more economical than the duplex lamps. The globes used on the latter are more expensive and are more frequently broken. The unequal expansion produced by heating the side adjacent to the arc and the sudden change in temperature from the shifting of the arc to the other side, always lead to this result in double lamps. The loss on them in this direction alone would almost pay for the extra service of re-trimming single lamps. Moreover, owing to the crowded condition of the box of the duplex lamp, it is more apt to get out of order, and for the same reason is more difficult to readjust; and as carbons are not uniform in their lasting qualities, the loss from burnt holders reaches its maximum where this lamp is used.

Outside lights give more reliable service when hung rigid, and the same is true for inside lamps, unless a device similar to that exhibited at Chicago by the Western Electric Company be used. Light hard-wood ladders and a good lamp man will have a better effect upon operating expenses than the ordinary loose tackle for raising and lowering. The ladder is of course less convenient, but a lamp properly trimmed with it is in no danger from the frequent variable contracts caused by raising.

In the use of carbons, a certain amount of waste must always result; but this item can be considerably reduced by trimming short-time lamps with pieces. The carbon question properly belongs to another committee, but it may be said here that chief grades are a constant source of annoyance and loss.

Globes are a vexatious part of the best lamps, and swell the item of breakage despite the utmost care. In fact there is no profit in them, except for the manufacturer. Nine-tenth of this breakage is due to the unequal expansion resulting from over-heating. The most feasible of the proposed preventive measures would be the use of a sheet of asbestos packing, which would insulate the globe from the undue heat at the lamp base.

Perfect trimming of lamps, as early as possible in the day, should be insisted upon. Switches, bases and all contacts must be well cleaned. Rods should be wiped before being pushed up, and in scouring them nothing but crocus cloth should be used. In exposed places, they should also be provided with protectors All screws and contacts must be kept tight. A careful lamp-man, without patrol duty, can trim 100 lamps per day, while for one who patrols his own circuit from 25 to 50, according to distribution and service, is a reasonable number. Such men are worth at least $1.50 per day.

With reference to the lamp department, there should be a thorough system of at least fortnightly inspection, with reports of trouble and breakage, and their causes.

With careful attention the expense in the lamp department should not amount to more than 28 per cent. of the operating expenses.

As the cost of installation and attendance is generally borne by those manufacturing light, as all fixtures are usually furnished by them, and as the change in seasons produces by slight variations in operating expenses, it is only fair to ask that the revenue be equally uniform. Hence contracts should be annual; circuits should not be cut for transient business without adequate compensation. This is difficult to fix, but it should be at least one-third more per month than the yearly rate.

We do not offer this paper as a satisfactory or comprehensive report on operating expenses. Data upon which to found estimates of real value have not been accessible, owing to an evident reluctance to make them known. The subject is, however, one of the most important that can occupy our attention. Upon it chiefly depends the future spread and financial success of electric lighting. Our business is new, and its operation is so different from that of other industries, that we cannot draw largely from their experience. At the same time, the public is no longer so patient of slow and awkward experiments at its expense as it was in the early days of telegraphy. People demand immediate perfection in the thing for which they pay.

It therefore behooves each one of our members to give freely and fully of his experience to our common fund of knowledge, that our industry may gain a sure and substantial paying basis in the shortest time possible. We would therefore suggest that a standing committee be appointed to receive statistics in regard to the various operating expenses; that this committee adopt a form of blank analysis to be furnished to each member of the Association, whose personal duty it shall be to fill out such blanks monthly, and forward them to the chairman of the standing committee; that this committee compile and present to the annual convention of this Association general statements as to the operating expenses of various plants, both arc and incandescent. This information should, of course, be received by the committee in perfect confidence, and should be used only for the benefit of members of the Association.

There are many ways in which our interests might thus be promoted. For instance, it may appear that A, running a 300-light plant, has an expense of 2 cents per lamp per hour in the lamp department (repairs, globes, carbons and attendance), whereas that of B, with a business of like extent, amounts to 2, 3 or 4 cents, and in the power department A

may be spending 3 and B but 2 cents per lamp per hour. The chairman would then direct A to confer with B in regard to power, and B to correspond with A in reference to the lamp department.

Unless some such method be adopted, any treatment of the subject will be of little value; while, with such a system, reports could not fail of most important beneficial results.

THE INCANDESCENT LIGHT.

The next business on the programme was a paper on the "Incandescent Light," by Dr. Otto Moses, of New York.

Dr. Moses: "Mr. President and gentlemen of the convention, I have not prepared a report on the subject of incandescent lighting, but I would be very glad, in an informal extemporaneous way, to present some things which were not embraced in the paper by Mr. Beane, and which probably have not been given in any publications that have appeared so far. What I propose to give is a little of the inside working of the incandescent light. I am a great believer in the doctrine that our president has announced as the one that should prevail, namely, that we are here for the purpose of giving and receiving information. Ours is not a mutual admiration society; but it is one in which what we have, we give; and I come to give that which I hope will be well received, particularly as it is a free gift.

"Incandescent lighting, as you know, has been advancing ever since the time of Sir Humphrey Davy, in various periods of development. He was really the discoverer of the incandescent light, and he produced some results with it that to-day would be extraordinary if witnessed. For instance, he used batteries of over 1,800 volts intensity That would produce in carbons of the thickness then used, results that would be perfectly overwhelming; and it astonished his audience, one of the most brilliant in England. After Sir Humphrey Davy, Starr commenced his experiments, and had he not died at the early age of twenty-seven, it is very likely he would have brought the incandescent light to a point where it would have been ready for adoption when the dynamo machine was invented, at a subsequent date. Then there was another period, that of Boulyguine, Konn and Lodyguine. They used in St. Petersburgh incandescent lamps for actual illumination. One of those gentlemen—I forget which one—was a merchant who was interested in scientific subjects, and he devised this lamp and put it in his store, and it brought a corresponding increase of business to him. People from all parts of the country visited him, and his lamp was thought worthy of honorable mention by the French Academy of Sciences. After that, Moses Farmer began to work on the incandescent light, and another American—Sawyer. At the same time Swan in England appears to have made certain experiments on incandescent lighting in vacuo. But all these experiments were not much in advance of what Sir Humphrey Davy had done fifty years before. In 1865 incandescent lamps had been used for scientific purposes. They had also been used for mining purposes, so M. de Changy says; but we have nothing to substantiate that statement. During the Paris Exposition he had an admirable opportunity to bring his electric light before the world. But he neglected it. I believe there is a legal maxim, that if one neglects a right, he forfeits it. At any rate, he brought out a paper in which he claims this thing, and figures the lamps exactly like those now in use. I took occasion to investigate his published claims, and I found, as I say, that they are insubstantial.

"After that period we come to the new one. Thomas A. Edison, assisted by a number of co-laborers, took up the subject of incandescent lighting, and in a couple of years brought it to a state of great development and perfection. Swan took up the subject which he had neglected for a number of years, and commenced to work in that direction, assisted by several persons. Mr. Crookes also began to study the matter. His previous information, and what he had done for the world, enabled him to do that with the best grace in the world; because, had it not been, I think, for the investigations of Mr. Crookes, incandescent lighting to-day would not have been in the position in which it now is. Mr. Crookes, as you know, is a very able scientist, originally a chemist, but a man of multifarious development scientifically. In 1878 he took up the subject of the study of gases in vacuo, and he, in connection with a co-laborer, Mr. Gimingham, (a glass-blower), did a great deal to render incandescent lighting possible; because all the preliminary facts connected with the study of the vacuo were carried to a finished point of development. For instance, he was enabled to produce vacuo of one two-millionths of an atmosphere. As some one remarked, that is equivalent to saying one one-hundredth of an inch of mercury in a barometic column three miles high. That will give you some idea of the perfection of the vacuo that he produced. Contemporaneously with Mr. Crookes, Mr. Gassiot, Mr. Spottiswoode and Mr. De La Rive, all assisted by wealth, carried their investigations to a very high point of refinement. You know Mr. Spottiswoode had an induction coil made that would give a spark 40 in. in length, and Mr. De La Rive made use of the most complicated apparatus for producing all degrees of perfection in the vacuum, the eliminating of certain gases, the absorption, for instance, of oxygen and carbonic acid, and all those refinements which are necessary if you wish to study the phenomena in their perfection. After that Mr. Edison commenced his investigations and perfected the mechanical parts of an incandescent lamp. His lamp was at the Paris Exposition, and there found much favor. At the same exposition were the lamps of the United States Company, (Maxim lamp) and the lamps of Swan and St. George Lane Fox. However, the incandescent lamp was simply a matter of progressive development. Sir Humphrey Davy showed that it could be produced by incandescence of small carbon rods, made from vegetable fiber in vacuo; Starr had done the same thing over mercury. Boulyguine, Konn and Lodyguine had done it by the use of stoppers. That is, they had made vacuo and had tried to stop them with cements. At that time Geisler had made his vacuum tubes in which he had rarefied mediums, but hisvacuo were maintained by the fusing of glass, so that they were practically perfect. And, as an interesting fact, I may say that a vacuum tube was prepared by Prof. Quincke over twenty years ago, and he has been weighing that tube at intervals since, and it is exactly to-day in the same physical condition in which it was then. It is simply a glass vacuum tube fused off, so that the fused globe having a vacuum inside will absolutely not leak.

"The next thing I would like to call your attention to is that every vacuum tube prepared to-day does leak, and it leaks because platinum wire is not glass, and there is an air film between, but that film is so infinitesimally small, that probably it would take a hundred years before it would leak; that is, before it would become subject to the same atmospheric pressure that prevailed around it.

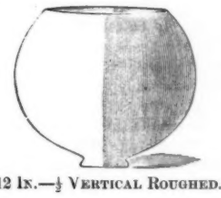
"I would like to call the attention of those who desire to take up that subject or who have been engaged upon it and would like to improve in it—I would say to them that the opportuni ies are considerable for the development of incandescent lighting. I would like to call the attention of the convention to what particular points it is capable of development, so that they make work out on those lines—such lines as I have selected myself to follow up. As an exemplification, however, of what an incandescent light is, I have introduced this [exhibiting a lamp] at the request of the president. This is a lamp

10 In.—Opal.

10 In.—Roughed all over.

14 In.—Clear Flint.

9 In.—½ Horizontal Roughed.



12 In.—½ Vertical Roughed.

Fig. 2.—Electric-Light Globes of the New England Glass Works.

together. It is only because they expand in the same ratio that you can apply a surface of platinum to a surface of glass and get a perfect stopping for a vacuum. I do not know in the whole range of sciences where I can point to a fact where so much depends upon one trifling circumstance.

"The next organ is the incandescing portion of the circuit which is enclosed in that vacuum. A little recapitulation there will be necessary. As stated, Sir Humphrey Davy already used carbon for that purpose. But platinum was known, too. All the aerometers that are used for the explosion of gases in vacuo, for the analysis of gases, contain platinum electrodes. Then platinum was used as an incandescing conductor. In 1864, I had the pleasure, as a student, of making an incandescent lamp, consisting of eight incandescent lamps in the one fixture. The object of it was a purely scientific one, though practical in its bearing. It was to make use of the incandescence of platinum for the purpose of indicating variations of movement. I applied it to an anemometer, and I have the pleasure of saying that it met with the approval of the eminent astronomer M. Le Verrier, who has charge of the Astronomical Observatory in Paris. Staite found that iridium was better than platinum for certain purposes. Then came the period of carbon taken up by this triumvirate of Russian physicists, and also improved very much by Mr. Sawyer, who died some years ago. It is scarcely necessary to say, that almost any organic substance will furnish a carbon, that can be used for electric light purposes—all except those that have nitrogen in their composition. It is said that silk may be used for incandescing conductors. Experiments I have made, show that silk disintegrates under it and forms flocculent scales. You can change the character of it by eliminating the nitrogen, and it is probable that has been done. But almost all organic substances will furnish a matter for the incandescing part of the electric light circuit. Carbon, as you are aware, has wonderful electrical properties. It will permit of the passage of currents very easily and it is very homogeneous. That is, for given lengths it retains its resistance, but there is this one property that must be called to mind, that by increasing increments of heats in the preparation of the carbon you can diminish its resistance. A metal heated returns to its original resistance approximately, though some of them expand more than others, and do not retain their original diameters, but with a very small degree of variation. Carbon, however, possesses that wonderful property, so wonderful a property is it that you must look to something in its chemical nature for the cause of it. I have examined the spectrum of carbon incandescing loops up the point where they have disappeared under the strong influence of powerful currents; that is, they have been volatilized, and I find that invariably hydrogen is present in the spectrum up to the last point of separation. Carbon, as I said to M. Dumas—who was the greatest authority on the subject of carbon of this country—as I said to him, "I do not believe that such a thing as carbon exists," and he said, "I have very grave doubts of it." But carbon, with infinitesimally small proportions of hydrogen, may be called carbon. The diamond is probably the purest form of carbon that we have, but below the diamond, in the scale of hardness, I think you may say that carbon is almost invariably united with hydrogen, and one or more atoms of hydrogen will continue to go off with every increment of the heat you give it, until the proportions become overwhelmingly carbon and infinitesimally hydrogen; that is to say, you can go on heating carbon until the hydrogen is driven off, and you then acquire more and more peculiar qualities in your carbon. Its resistance diminishes. Its density increases. It becomes gray in its color until finally it reaches a quality approaching the diamond; and it is not improbable that the diamond was produced by the elimination of the hydrogen from the carbon by intense heat. All other forms of these carbons are amor-

(*Continued on page 7.*)

I have been at work on two or three years although the principle has been applied by me years before. The lamp as you see it here—any lamp could answer the same purpose—consists of the following organs: A glass globe evacuated, either hermetically sealed by making it a continuous glass globe or not hermetically sealed, and stopping it. In this case my lamp happens to be stopped with the only material that will not allow of an admission of the atmosphere into it. That is, as you are well aware, platinum. The lamp that I have in my hand is a stopper lamp. This stopper is of platinum. And I would like to call your attention to this very remarkable fact which enables incandescent lighting to be possible, which is this, that platinum and glass have identically the same coefficient of expansion. That is if I heat a platinum wire and a glass rod of the same dimensions and notice the dilation, I will notice they have increased exactly the same in length and the same in width. You put these two things together and you have under the applications of heat the same expansions. And here comes another very wonderful thing for which we should be very thankful, it is that platinum is a very poor conductor of heat, so is glass. If those two substances, having the same coefficients of expansion expanded in different times, in different ratios, it would not be possible to unite them

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We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

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It is funny, but nevertheless true, that an electric-light worker sometimes has to adjust his wires by the aid of a tallow candle.

"Cog hog to rog. Jags is not 100." This looks funny, and it is to expert telegraph operators. What tried to go over the wires was: "Come home to Rome. James is not well."

Mr. Thos. A. Edison was married to Miss Mina Miller of Akron, Ohio, February 24, Lieut. F. W. Tappan, U. S. N., acting as groomsman. Mr. and Mrs. Edison will spend the winter months at the groom's Florida home.

The Missouri and Kansas Telephone Company, through the excellent management and the faithful work of its officers, has again reached a dividend-paying basis, which bids fair to continue. A dividend of 11 per cent., payable in stock of the company at par, was declared at the annual meeting, January 27. Certificates will be issued for the even shares, and the fractional shares will be issued in the form of scrip, redeemable in the capital stock of the company, when presented at the office of the company properly indorsed, in amounts representing multiples of one hundred dollars.

Mr. Wm. A. Jackson, of Detroit, Mich., one of the best-known and most capable telephone men of the West, is spending a few days in this city. There is no abatement in the demand for telephones in his city, upwards of 2,300 being in use there at the present time. The excellent management of the business by Mr. Jackson's company, which has given the service the advantage of every improvement, has resulted in making it popular with all the patrons in the State—an achievement of no small consequence in these days of hostile and ignorant legislation. Mr. Jackson is also one of the proprietors of the Detroit Electrical Works, and it is chiefly in the interest of this large and growing electrical establishment that he visits the East.

The second edition of Sylvanus P. Thompson's "Dynamo-Electric Machinery" has recently been published by E. & F. N. Spon, 125 Strand, London, and 35 Murray street, New York. This edition is enlarged and revised, and much new and valuable matter added. Many additional forms of dynamos are described, and the latest information concerning electric motors is given. The work is a very valuable one, and containing, as it does, all the best parts of the first edition, as well as a complete history of dynamo-electric progress, extending over the period of fourteen months which have elapsed since the publication of the first edition, will be of increasing interest to former readers, and invaluable to the apprentice and student. The REVIEW will forward the work to any address in the United States and Canada, on receipt of the price, $5.

The American Electrical Works, of Providence, the better to serve their customers, and to carry out a long-contemplated plan, have leased a fine suite of offices, in this city, at No. 15 Cortlandt street, and engaged Col. Geo. L. Beetle as their representative. The class of work sent into the electrical field by this well-known house has been second to none, and their decision to establish a New York branch, with Col. Beetle at the head, is not only evidence of their enterprise, but indisputable proof that their goods are appreciated and in demand by the electrical public. In taking this step, they have, we think, acted wisely; and, in securing Col. Geo. L. Beetle as their agent, have completed an already energetic staff by the addition of probably the best-known and most popular gentleman connected with the electrical fraternity in this country. His many friends will accord him a most cordial welcome, and to him and his wide-awake company the REVIEW is pleased to extend its congratulations and well-wishes for the abundant fruit that this new and advancing move is sure to bear.

The Supreme Court of Indiana has decided that the law fixing the annual rent of telephone sets at $36 is constitutional. This will be a severe blow to the telephone interests of that State, and we cannot see where either fairness or equity has appeared as a factor in the minds of the court. The opinion says:

The ready and, indeed, inevitable answer is that the question thus presented ought no longer be regarded as an open question. There is a reserved and, at the same time, well-recognized power affecting their domestic concerns remaining in all the States which the Government of the United States cannot and has seldom attempted to invade. This power is sometimes denominated the "police" power of a State, and embraces the entire system of internal State regulation, having in view not only the preservation of public order and the prevention of offenses against the State, but also the preservation of such intercourse between the inhabitants as is calculated to prevent a conflict of rights, and promote the interests of all. . . . It is now a well-settled legal proposition that property thus devoted to a public use becomes legitimate subject of legislative regulation and control. . . . The obvious deduction from what has been said, as well as from the authorities cited, is that the power of a State Legislature to prescribe the maximum charge which a telephone company may make for services rendered, facilities afforded, or articles of property furnished for use in its business, is plenary and complete.

The Sims-Edison Electric Torpedo Company has been incorporated by Thomas A. Edison, Charles Bachelor, Gardiner C. Sims, W. Scott Sims, Lewis May, John Anderson, Wm. M. Deen, Frank W. Allen and Geo. H. Stayner. It is to manufacture, sell and use torpedoes, torpedo-boats, submarine vessels and war ships, dynamo machines, electric cables, wires, motors and lights, and also steam-engines, boilers and supplies. The officers of the company are: John Anderson, of New York, president; Gardiner C. Sims, of Armington & Sims Engine Company, vice-president; Lewis May, treasurer; Frank W. Allen, secretary; W. Scott Sims, general manager; T. A. Edison, consulting electrician; Gardiner C. Sims, consulting engineer. This constitutes a strong financial, electrical and mechanical organization, and it will undoubtedly achieve the highest results in this new branch of electrical work.

DEATH OF PRESIDENT SMOOT OF THE WESTERN ELECTRIC CO.

William Sidney Smoot, president of the Western Electric Company, died of diptheria last week at Evanston, Ill., aged forty years. He was the son of Admiral Smoot, of the United States navy. At the age of eighteen he was transferred from a captaincy in the volunteer service to the Ordnance Corps of the regular army, with the rank of lieutenant, and was stationed during the latter part of the war at the United States Armory, in Springfield, Mass. While there he was the author of a small work on ordnance. Re signing from the regular army, he was for several years superintendent of the Remington Armory, of Ilion, N. Y. He next took considerable interest in stock-raising in Montana, where he had a large ranch. A little over a year ago, on the resignation of Gen. Anson Stager, he was elected president of the Western Electric Company, and took up his residence in Evanston, where he leaves a young wife and seven children. His mother, over eighty years of age, is still living in Washington. The electrical fraternity has lost one of its most capable and honorable members—a gentleman of broad views and great energy, whose work would have had a noticeable effect on all electrical industries, in which he was taking a most active interest.

A NOVEL MEANS OF THWARTING COMPETITION.

We alluded some time ago to the absurd pretentions of what would like to be a great monopoly; striding and swaggering over the electric lighting field concealed in an ill-fitting lion's skin for a disguise.

The last and most astonishing method of criticising competition is made against the Schuyler Electric Light Company. The gravamen of the complaint against the Schuyler Company would seem to be that its incandescent lights are so efficient and reliable that the pretended monopoly's patrons are a-hunger and a-thirst for it. This, of course, is a serious charge.

It seems that the Schuyler Electric Light Company has recently been making great strides into popular favor in the South-west and South. Unable to stay this progress of the Schuyler incandescent light by competition in the lighting field and a comparison of lights, the would-be monopoly has hit upon another and a less commendable means. Dickens makes one of his characters advise a litigant: "If you can't beat them on the merits of your case, the next best thing is to abuse plaintiff's attorney." Following the same method the disjointed electrical octopus, with a mendacity at once artless and picturesque, recently published and distributed through their agent the following proclamation—we give it *verbatim et literatim*:

"ELECTRIC LIGHT!

"The people of Louisiana should be very careful how they hang their faith on upstart electric companies represented by drummers, whose pay depends merely on sales or "pull-ins." There are a few companies that have passed the experimental day and can be relied upon. All others should be shunned until they drop the swaddling clothes of experiments, and the Schuyler Electric Company is one of them.

W. J. DOUGHERTY.

"Representing the Edison Electric Light for Louisiana."

Did ever incandescent impudence go farther than this!

We have heard of rival companies publishing insinuations against competion, but this is the first time in our experience when a company claiming to be reputable, actually vilified and spread malicious falsehoods against another, in print and over their own signature.

Hence, to Dougherty and his company should be awarded the metaphorical and innutricious cake, for verily in the composition of Dougherty and his sponsors, the courtesy and manners of the hedgehog are blended with a nerve that the broadside of a man-of-war would not serve to shake.

It behooves us, at this point, to enquire how much of this sphere in which we live belongs in fee simple to the Edison Company, and over what elements in its construction—fire, water and atmosphere—they are the lords; else we may discover that we are, all of us only squatters who, if justice were done, should pay an annual fee into their coffers.

We are led by this train of thought to recall another such instance of the assumption of universal domain by uncrowned mortals.

We take it from the *Chronicon Canonicorum Regularium Ordinis Augustini*, Antrerpiæ (1621).

"In the end of the fourteenth century, the monks of the celebrated but long since destroyed monastery of Augustines at Windsheim, in the province of Overyssal, were desirous of erecting a windmill not far from Zwall; but a neighboring lord endeavored to prevent them declaring that *the wind in the district belonged to him.*

"The monks, unwilling to give up their point, had recourse to the Bishop of Utrecht, under whose jurisdiction the province had continued since the tenth century. The Bishop, highly incensed against the pretender who wished to usurp his authority, affirmed that *the wind of the who'e province was his own individual property*, and in 1391 gave the convent liberty to build a windmill and *express permission to use the wind for a certain period.*"

We are not informed whether or no the Edison Company claim the exclusive right of using the wind. But we do know that they consume large quantities of it, not, however, in driving windmills, but in the less commendable occupation of exaggerating their own importance, and inciting such shallow-pated bumble-heads as this Dougherty seems to be, to issue proclamations against rival, though quite as efficient, apparatus as they possess themselves.

The most remarkable thing about this circular of the Edison Company is that it contains a virtual admission, if it is not a public acknowledgment, that it regards the Schuyler Electric Light Company as a formidable rival. Now, if the Schuyler Company furnishes so efficient an electric-lighting service when yet, as the circular avouches, it is but in its "swaddling clothes," perhaps, in the future, when it shall have exchanged these appendages and suits of infancy for the habiliments of maturity, it may become really invincible and drive the Edison Company's lights altogether from the field. Indeed, the Schuyler Company could not have a better recommendation than is furnished here in the evident state of mind, if not absolute panic, of a company which has laid such claims to excellence as has the Edison Company; and, if the Schuyler people have half the enterprise they are credited with, they will have this "dodger" of the Edison Company reprinted in all its wildness and vagaries of type, and distribute it with an explanatory card to their correspondents throughout the country.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

ALPHABETICAL LIST OF MEMBERS.

Geo. D. Allen, 13 Dey street, New York; American Manufacturing Co. (Electric) New York; Allegheny Co. Light Co., Pittsburgh; Albany Electric Illuminating Co.; Armington & Sims, Providence, R. I.; Ansonia Brass & Copper Co., New York; H. C. Adams, Agent for Holmes, Booth & Haydens; American Electrical Works, Providence; Brush-Swan Electric Co. of New England; Brush Electric Co., Philadelphia, Pa.; Brush Electric Illuminating Co, New York; Ball Electric Manufacturing Co., Reading, Pa.; Bridgeport Electric Light Co., Bridgeport, Conn.; Brookline Electric Light Co., Brookline, Mass.; Geo. S. Bowen, Elgin, Ill.; Benedict & Burnham, Waterbury; Wm. Baxter, Jr., New York; Brush Electric Light Co., Boston; Boulton Carbon Co., Cleveland; Brush Electric Light Co., Baltimore, Md.; Brush Electric Light Co., of Detroit, Mich.; Brush Electric Light Co., of Cleveland, Ohio; Brush Electric Light Co., Indianapolis, Ind.; Bridgeport Brass Works; Geo. H. Benjamin, New York; Brown Electric Co., Pittsburgh, Pa.; Bernstein Electric Light Manufacturing Co., Boston; Bishop Gutta Percha Co., New York; Wm B. Cleveland, Cleveland, Ohio; Consolidated Electric Light Co., of Maine; Callender Insulating Co., of New York; Charles Cooper, Brooklyn, N. Y.; Chemical Electric Light & Power Co., Boston; F. E Caton, Boston; Gilbert Donaldson, St. Paul, Minn.; Daft Electric Light Co., Greenville, N. J.; Daft Electric Light Co., New York; A. J. Dam, New York; D. H. Dorsett, Chicago; ELECTRICAL REVIEW, New York; Electrical Supply Co., New York; Electric Supply Co, Chicago; Elgin Electric Light Co., Elgin, Ill. (Geo. S. Bowen); Geo. Worthington, New York; Elizabeth Electric Light Co.; *Electrician & Electrical Engineer*, New York; Fort Wayne Jenney Electric Light Co.; Fitchburg Steam Engine Co.; Forest City Electric Co., Cleveland; Guernsey-Scudder Electric Light Co., St. Louis, Mo; William Hochhausen, 13 Dey St., New York; Clark B. Hotchkiss, New York; Holyoke Electric Light Co., Holyoke, Mass.; J. M. Hill, New York; Indianapolis Brush Electric Light Co.; Jarvis Engineering Co., Boston, Mass; Joseph Jepson, Norwich Electric Light Co.; Jones Albert L., Dam. L. H. & Power Co., Hamilton, N. Y.; Jamestown Electric Light Works, Jamestown, N. Y.; Jenny Electric Co., Indianapolis, Brainard Rorison; Kansas City Electric Light Co., Kansas City; William L. Libbey & Son, Boston, Mass.; H. M. Linnell, Hartford, Conn.; La Crosse Electric Light Co., La Crosse, Wis.; Lewiston & Auburn Electric Light Co., Auburn, Me.; Mitchell, Vance & Co., New York; Minnesota Brush Electric Light Co., Minneapolis; Moorse & Whyte, Boston, Mass.; Municipal Electric Light Co., Brooklyn, N. Y.; Chas. McIntire Newark, N. J.; McKeesport Light Co., McKeesport, Pa.; Dr Otto A. Moses, New York; Merchants' Electric Light & Power Co., Boston,; George A. Mayo, Boston; New Haven Electric Co., New Haven, Conn.; North Adams Electric Light Co., North Adams, Mass.; J. F. Noonan, Paterson Electric Light Co.; New York Insulated Wire Co., 33 Oliver street, Boston; New England Butt Co., Providence, R. I.; Newport Illuminating Co.; New Bedford Electric Light Co., New Bedford; Northern Electric Light Co., Philadelphia (George W. Boyer, President); Thomas Officer, Council Bluffs; Onega Manufacturing Co., New London, Conn.; Okonite Co., New York; Poughkeepsie Electric Light & Power Co.; Pittsburgh Carbon Co; Parker-Russell Mining & Manufacturing Co., St. Louis; R. W. Pope, 11 Wall street, New York; Pilcher, Council Bluffs, Electric Light Co., Council Bluffs; Paterson Electric Light Co., Paterson, N. J., (J. F. Noonan); John A. Roeblings & Sons' Co., New York; Royal Electric Light Co., Montreal; Riverside & Oswego Mills Providence, R. I.; Swift Electric Light Co., East Saginaw; Schuyler Electric Light Co., Hartford; Springfield Electric Light Co., Mass.; Springfield Steam Supply & Electric Light Co., Springfield, Ill.; Star Iron Tower Co, Fort Wayne; Southern Electric Co., Baltimore, Md.; Standard Underground Cable Co., Pittsburgh, Pa.; Sperry Electric Light Co., Chicago, Ill.; Schultz Belting Co., St. Louis, Mo.; St. Joseph Electric Light Co., St. Joseph, Mo.; St. Louis Electric Co., St. Louis; Arthur Stewart, Baltimore; Straight Line Engine Co., Syracuse; Thomson-Houston Electric Light Co., Philadelphia; Taunton Electric Light Co., Taunton, Mass.; United States Illuminating Co., New York; Van Depoele Electric Manufacturing Co, Chicago; Vitrite & Luminoid Co, New York; Viaduct Manufacturing Co., Baltimore, (A. H. Bauer); Worcester Electric Light Co., Worcester, Mass.; Westing house, Church, Kerr & Co., New York; Western Electric Co., New York; Washburn & Moen Manufacturing Co., New York; Waterhouse Electric & Manufacturing Co., Hartford, Conn.; A. M. Renshaw, Washington, D.C.

GENERAL WESTERN NEWS.

The suggestion that he who gets first into the patent office with a claim is entitled to the patent is a new and possibly a very simple way of settling patent priority disputes. If this be the rule adopted, how many tedious and expensive patent suits will be avoided. If the thousand and one telephone inventions are to be brought out now, and permitted by the courts to run riot over the country like a plague of locusts until the present celebrated case can be poulticed up to the sticking point, heaven help the country! Telephone exchanges are not like corner groceries—the law of competition is not the same in both instances. Chicago has to-day the premonitory symptoms of what seems rather an epidemic than a sporadic exhibit of telephone exchanges; and if the present subscription list were to be divided fairly among the new concerns, the whole business must of necessity go, as Mr. Mantalini would say, "to the dem bow-wows."

The Northwestern Overland Telephone and Telegraph Company held a meeting on the 10th for the election of officers, and to consider the future business of the company here. The company has charters granted by the States of Illinois, Iowa, Minnesota, Wisconsin, and Dakota Territory, but so far no lines have been constructed.

A committee, consisting of A. C. Bartlett, S. B. Baker, Henry J. Christoph, C. M. Henderson, and Ferd. W. Peck, was appointed to get estimates for the establishment of an exchange, and the laying of wires in the city. It is claimed that there are 2,500 subscribers ready to enroll when matters assume definite shape, and the company claims to be able to supply telephones and service for about half the existing rates.

If the old adage about the worth of anything being so much money as 'twill bring, what sort of service would one about half as good as the present, which the *Tribune* calls the Bobtailed system, be?

The library of the American Electrical Society has just been placed in the City building, in a room which has been provided adjacent to the fire alarm office, and the office of the City Electrician, Prof. Barrett, who is one of the Executive Committee of the Society, and in whose charge the library will permanently remain

Hereafter no books will be taken from the library room, which will be literally a reading room. Chairs, table, light and warmth are furnished by the city, and every necessary convenience thus placed at the disposal of those who are entitled to these privileges.

Prof. Barrett is called upon to mourn the loss of an infant son, whose funeral took place on the 10th instant. The professor and the family have, in their bereavement, the warmest sympathies of the electrical fraternity here, as well as of their otherwise large circle of friends.

CHICAGO, February 22.

BOSTON ELECTRICAL NEWS.

The Martin-Wilson Automatic Fire Alarm Company, 53 State Street, Boston, Mass., are equipping the extensive establishment of Houghton & Dutton with the Martin-Wilson closed-circuit fire alarm system. There will be used 350 thermostats, 16 station indicators, and 16 manual alarms. A rebate in premiums paid for insurance is allowed by the underwriters, enabling the firm to save several hundred dollars yearly.

Goodnow & Wightman, 176 Washington street, have on hand castings and parts for small dynamo, capable of supplying current for 5 candle-power lamp, and for other experimental work.

The New England Weston Electric Co. expect soon to have their present motive-power increased to the extent of 200 horse power. The quantity meter, recently devised by Mr. Weston, is very accurate and satisfactory in its action, and will be soon used in large numbers. At present each series of incandescent lights is charged for by time-meters. The company have wired the new part of the Parker House for incandescent lamps, and the lamps will be furnished with current from the Stanhope street station.

The Electrical Development and Manufacturing Co. have nearly completed their contract with the American Electric Manufacturing Co. of New York for 1,000 Fuller-Wood lamps, and are expecting increased orders.

The Northampton Electric Light Co., using the Thomson-Houston system, was started Feb. 12, with 30 arc-lights. The quality of the lights was much appreciated.

The annual meeting of the stockholders of the Thomson-Houston Company was held at New Britain, Conn. The old board of directors was re-elected. The report of treasurer was very satisfactory.

Charles L. Bly, 37 Pearl street, has been erecting for the Pennsylvania Steel Co. one of their electric interlocking switches at Harrison Square, on the tracks of the old Colony railroad. During Dec. 1885, Mr. Bly set the poles and strung the outside wires for the incandescent station at New Bedford, to run 2,500 lights. He is now adding six miles of wire on poles for the same station.

Mr. A. H. Cowles, of the Cowles Electric Smelting and Aluminum Co., read a paper Feb. 11, before the Society of Arts, Boston, on "The Cowles Electric Furnace and the Production of Aluminum and its Alloys." The paper was rendered very entertaining by the large number of specimens of reduced metals and manufactured articles made from the various alloys. The company expect, as soon as their new factory at Lockport, N. Y., is completed, that by using water as a motive-power aluminum can be made in their furnace from corundum, at a price not greater than 80c. per pound. Inasmuch as aluminum is twenty times as good a conductor as an equal weight of iron aluminum wire at $1.20 per pound would be as cheap as iron wire at six cents per pound. Further, the aluminum of same conductivity would weigh between one-half and one-third as much as iron wire and a much less strain would be exerted on all poles, cross-arms and insulators. An additional advantage would be the non-oxidizable properties of the aluminum wire. A new 500 horse-power dynamo is being constructed by the Brush Electric Company of Cleveland for the new station at Lockport. This machine will give an electro motive force of 90 volts and a current of 28,000 to 32,000 amperes It may be said that it will be the largest practical dynamo machine ever built.

In the reduction of the corundum, which is mixed with charcoal and placed between two sets of carbon rods, there might be three causes: electrolytic action, heat of an arc, heat due to passage of a large current through a high resistance. There is probably no electrolytic action, as, when a number of substances to be reduced are placed in the furnace, there is no difference between the reduced metals at the two carbon poles. It is not likely than an arc is formed, as neither of the carbon rods seem to waste away or increase in length.

The New York Insulated Wire Company have recently engaged extensively in the manufacture of lead-covered wires, made into cables, containing from one up to any reasonable number of conductors, which are either B. D. rubber-insulated copper wires, or of the Grimshaw white core type. The Grimshaw tape made by this company is, when carefully wound upon bare wire, the only insulation needed. Forty miles of the land wires, in cities, of the Mackay-Bennett Cable Company, were insulated with this tape.

Mr. Paul Bossart, the efficient superintendent of the Worcester division of the New England Telephone Company, will in the future be associated with Mr. Edison in the management of Edison's Way Duplex system. The telephone company regrets to lose Mr. Bossart's able services. Up to the present time in the Duplex systems, the instruments were operated only at the ends of a line; however, this new invention enables any number of sounders to be worked in series on a long line, and will be of great advantage to railroad companies.

The Household Electric Light Company, 153 Essex street, Boston, have shipped a 20-light incandescent plant to light the harness-thread factory of Wm. Warren, Westfield, Mass., also a similar plant to the Cooper Water Motor Company, of the same place. They have just filled an order for a twenty and a one-light machines for Philadelphia. The machines made by this company are built under the Mather patents, and have all the excellencies of the larger machines.

The Edwards Manufacturing Company, of Augusta, Me., have had their mill lighted recently with 400 16 candle-power Swan incandescent lamps. The dynamo, a 450-light Brush-Swan compound-wound machine, is driven by a water-wheel, and the lamps give excellent satisfaction on account of their steadiness and brilliancy.

The Brush-Swan Electric Company, of Burlington, Vt., started their arc and incandescent plant Monday, Feb. 22.

The Magee Furnace Company, Chelsea, Mass., have made arrangements for a 180-light Bernstein plant to light their foundry, machine shop, finishing rooms, pattern shop and offices. The lamps will be in the main of 16 candle-power, and a few of 10 candle-power. The Stagl dynamo made by the Bernstein company is of the flat-ring type; the field of 4 poles is wound in series, and shunt so proportioned that any number of lights may be switched on or off, without affecting the brilliancy of the remaining lamps. The motive power will be a 25 horse-power automatic Ball engine.

The Sun Electric Light Company, of Woburn, Mass., have a fine, roomy factory in what was formerly a skating rink. They are making large numbers of surgical lamps of small candle-power. The pump room has a capacity to exhaust 200 16 candle-power lamps per day. There is a large demand for the Monster 120 candle-power lamps of this make, for lighting large spaces. These lamps require a pressure of 90 volts, and a current of 3 amperes. A new type of electrical distribution, somewhat like the multiple-series system, will soon be constructed in Woburn, on a circuit 7½ miles long, to operate 400 16 candle-power lamps. So great will be the economy of installing this system that the conductors for this plant cost only $600.

The experiment of lighting the passenger elevator at 95 Milk street, Boston, from primary batteries, was terminated on the 17th inst., after accomplishing a total of 548 hours on a single charge of Volta-Pavia solution. It was necessary to renew the inner porous cup twice, in order to exhaust the outer Volta-Pavia solution; but this renewal was merely a matter of labor rather than expense, as the dilute acid solution is very cheap.

The experiment started January 1, 1886, with two 8 candle-power lamps, but the light was found to be too much for the space, and on the 3d our lamp was removed, and for forty days thereafter one 8 candle-power lamp lighted the elevator satisfactorily an average of 8½ hours a day, This proves that in a private house a plant of Volta-Pavia batteries would supply light four hours a day for eighty-seven days.

The Thomson-Houston Electric Light Company, of Boston, have removed from 131 Devonshire street to 178 Devonshire and 33 Federal streets. Here they have a large suite of rooms for offices and for a supply room, where various parts and devices of the system will be kept in stock. The company has installed a 45 arc-light plant at Wood land, Cal.

BOSTON, Feb. 24.

Telephonic News

⁂ Birmingham, Ala, has the largest list of telephone suscribers of any city in the State.

⁂ Holmes, Booth & Haydens, of Waterbury, Conn., are building two large brick additions to their factory.

⁂ A good name and a clear concience are worth more than $1,500,000 of Pan-Electric stock. The Attorney-General of the United States possesses the Pan-Electric stock.—*New York Sun.*

⁂ The fire chief and members of the Houston, Texas, city council decide that the present telephone alarm system in vogue in Houston, will answer all fire-alarm purposes of that city, for the next ten years to come.

⁂ The county asylum at Detroit is being fitted throughout with electric signals and alarms. The physician's office is to be connected with each ward, and the electric bells are considered a necessity to call assistance for the keeper, if necessary, and to give an alarm of fire. Signals can be sent both ways.

⁂ The Adirondack Telegraph and Telephone Company talks of building a line from Elizabethtown, through Schroon Lake, Pottersville and Chestertown, to Warrensburgh, in the spring. This company now operates lines in Keene, Westport and Elizabethtown, and has a charter enabling it to operate in Warren county.

⁂ A Lake Superior miner has invented a very ingenious contrivance, whereby signals can be given from the lowest depths of the mines, with the utmost distinctness and precision. The signal will be given by means of an electric bell, which will be heard by the person that gives the signal, as well as by the person receiving it. The entire apparatus can be placed in an iron box, six inches square. Signals can be given from any level of the mine.

⁂ The lower or Hamilton street branch exchange in Albany is to be removed to the main exchange on Broadway, the lines leading to the lower branch are to be brought to the main exchange through three Patterson cables—two 50-wire and one 100-wire. This addition to the main exchange will make the number of suscribers there upwards of 1,000. General-Manager Uline and Superintendent Cull are busily engaged getting ready for the removal, which will occur as soon as the connecting cables can be erected.

⁂ "I have a new scheme to spread the gospel," said an evangelist. "You know all sorts of people use the telephone, and, doubtless, you have observed the unsaintly frame of temper most of them fall into during the interval from 'Hello' to 'Hello.' Well, I'm going to form a society whose purpose shall be to chain a free Bible to every telephone in the country. This will give the telephoners something to read while waiting for a response, and so diminish profanity by increasing tranquillity. The result will be such a crop of Scriptural knowledge as has not been garnered in years."

⁂ One of the grievances that a Philadelphia gentleman has, arises from the fact that his desk adjoins the telephone closet, and that, consequently, he is compelled to answer the "phone," when the bell rings. Fully 100 times each day he has to shout, "Hello!" He says that it has grown to be a second nature with him to start when he hears a telephone bell ring. The other morning he wanted to get up early, and so set his alarm for 5 o'clock. He was in a heavy sleep, when the clock went, and, forgetting where he was, he hastily jumped out of bed, opened the closet door, and shouted: "Hello! hello! Who are you?" at the top of his voice. He was recalled to his senses, when he heard his wife asking whether he had gone crazy or was simply drunk. Then he kicked the alarm clock into the next room, and proceeded to dress.

⁂ The strongest wood in the United States, according to Professor Sargent, is that of the nutmeg hickory of the Arkansas region, and the weakest the West Indian birch. The most elastic is the tamarack, the white or shellbark hickory standing far below it.

⁂ A piece of iron, one end of which is red hot cannot be held with comfort, because it is a good conductor; but a short piece of charcoal, one end of which is incand scent, can be held with ease, because it is a non-conductor. A piece of tinfoil, placed on a card, and held over a lamp, melts, because the tin is a good conductor, and absorbs all the heat, whilst the card, being a non-conductor, does not keep enough to take fire.

⁂ The Central District and Printing Telegraph Company, Pittsburgh, held its annual meeting February 11th, and elected the following directors: D. Leet Wilson, James Merrihew, Chas. O. Rowe, Geo. I. Whitney, L. Halsey Williams, Jno. L. George, C. Jay French, and C. R. Truex. The directors elected officers as follows: President, D. Leet Wilson; vice-president, C L. Rowe; secretary and treasurer, Jno. G. Stoakes; general manager, Henry Metzgar.

⁂ The Bell Telephone Company, of Philadelphia, held its annual meeting February 16. and elected as directors, Henry Bentley, T. E. Cornish, T. N. Vail, C. R. Truex, J. J. Bailey, J. E. Mitchell, J. E. Kingsley, T. T. Eckert, C. A. Tinker, J. Merrihew, S. M. Plush, W. B. Gill. Officers were elected as follows: President, Henry Bentley; vice-president, J. Merrihew; treasurer, A. A. Ziegler; secretary, S. B. Huey; general manager, S. M. Plush.

Government Telegraphy.

It is in testimony before the Post Office Committee of the Senate that the railroad companies in the United States own thirty thousand miles of telegraph lines; that on the lines of the Western Union Company alone 30,000 operatives were employed in 1884; that in that year that company had 6,000 other employes, officers, superintendents, clerks and men engaged in construction and maintenance; that altogether the telegraph companies and the railroads, in their telegraph departments employ 50,000 men; and that all these men would be needed by the Government if it went into the telegraph business.

What a fearful stride toward centralism would be the addition of this army of affiliated operatives to the huge existing army of officeholders, and how great a power would thus be added to the political force of the party holding the administration! But this is only the shadow of the threatening peril.

It is also in expert testimony before that Senate committee that the telegraph business in the United States doubles every six years; that with the impetus to be given to it by political rates of transmission, which would necessarily be low, and the opening of additional offices on the demands of Congressmen, the business in the hands of the Government would be doubled in four years; that instead of 600,000 miles of wire, now sufficient for the whole country, we should have 1,200,000 miles of wire; that instead of 20,000 offices on all the lines, as now, the Government would have 40,000 offices; and that within five years the telegraphic addition to the Federal officeholding class would amount to 100,000 employes.

With this entire electioneering force at work in every part of the United States, would not third-term presidencies become easy, then become the rule, and in time become offices for life?

As the people value their liberties, they should cry halt to the politicians in Congress who are dicing with Government telegraphy. The assumption of the business would be the beginning of the end of democracy in America.—*N. Y. Sun.*

Bright Remarks on the Politico-Telephonic Situation.

A case is under argument in New Orleans at this moment which throws some light on the Pan-Electric movement. The Bell Telephone Company is there asking for an injunction to restrain the National Telephone Company from using its telephones. The defendants claim, in answer, that the court should not entertain the application pending the attack of the Government on the validity of the Bell patent. We shall probably now see this plea put in all over the country, and if it is found effective, the Bell Telephone company would for two or three years be a prey to all comers, its stock lowered, and that of hundreds of rival claimants correspondingly raised. We do not mean to say that this is a reason why the Government should not interfere, but it is a reason why the necessity of its interference should be clear beyond question.—*N. Y. Post.*

It shows the different way in which different men look at the same thing that Mr. S. S. Cox returned the stock which Dr. Rogers sent him, with a contemptuous note. Senator Harris, on the other hand, wrote: "I see no impropriety in gentlemen holding official positions, as Atkins and myself do, becoming interested in an enterprise such as you suggest." Mr. Garland was not only of the same opinion as Senator, but he held on to the stock which had cost him nothing when he became Attorney-General, and he holds on to it still, although he knows that its value hinges on an action taken by the Government, of which he is the chief legal adviser. It is a most extraordinary scandal to occur in the Cabinet of a reform Administration —*Boston Journal.*

Mr Garland must get rid of his telephone stock, or the Department of Justice must get rid of Mr. Garland.—*N. Y. World.*

Mr. Cleveland's Attorney-General is proving his right to be numbered among the pachydermatous statesmen. He seems to have no just conception of the offence he has committed against official morality, and imagines, apparently, that he need only put on a bold face and assume a dogged persistence, and the scandal in which he is involved will blow over. In his political decalogue an officer of the Government is not forbidden to use his official position to further his private interests. This is the view Mr. Garland evidently takes of his connection with the Pan Electric Telephone Company, unless his actions falsify his principles.—*Phila. Press.*

Mr. Garland cannot complain if people refuse to believe that he had no knowledge of Solicitor-General Goode's intended action. He has given warrant for lack of confidence by accepting a present which was given him for his influence. If he were a man of nice honor he would have refused the stock, as S. S. Cox and Abram S. Hewitt did. We regret to say that Mr. Garland ought to resign, and that the President ought to compel the resignation if it is not made voluntarily. —*Boston Post.*

When Mr. Garland was first engaged in behalf of the Pan-Electric Company, the question was put to him 'whether the telephone owned by said company, or any part of it, is an infringement on what is known as the Bell telephone?" To this Mr. Garland answered in writing that he had given the subject much attention, and had closely examined several opinions delivered by different courts in the controversy between the Bell Co., Dolbear, Spencer, and others, and "I am clearly of opinion that the Pan-Electric in no wise infringes the Bell telephone." This being the judgment of the present Attorney-General only a short time ago, why in the world was he willing that a suit should be brought in the name of the United States against the Bell Company? If there was no infringement, why couldn't they both get along together? Perhaps, however, such a suit against the Bell Company might afford favorable occasion for selling out Pan-Electric stock.—*N. Y. Sun.*

It will be particularly scandalous for the Attorney-General to prosecute a suit against one telephone company with the free stock of a rival corporation in his pocket.—*Wheeling Intelligencer.*

The greatest misfortune that can happen to Mr. Cleveland is to have his administration committed now to a thick-and-thin defence of Attorney-General Garland in the matter of the telephone scandal. Yet that is what some of the volunteer organs of the President are attempting to do.—*N. Y. Sun.*

Attorney General Garland has a shrewd business head. If expelled in disgrace from the Cabinet, he would contemplate with complacency his probable inability to return to the Senate, because:

Senator's Salary.	Telephone Stock.	Years.
$7,500)	$1,500,000 (	200
	1.500,0	
	00	

He would have to serve as Senator 200 years to earn as much as he now has in stock, and the probabilities are strongly against his being able to do it. Garland knows on which side his bread is buttered.—*Norwich Bulletin.*

The Attorney-General held certain papers, now wholly worthless, but which would be worth half a million dollars if the Bell patents are rendered invalid, and he is insisting that the Government shall institute an unnecessary suit for the benefit of himself and his co-partners, the Government paying liberally for the expenses of a case entered upon for the benefit of the Attorney-General and his coadjutors. This is not the whole of the scandal in its legal aspect; but it should suffice to arouse the attention of a Democratic Civil Service Reform President. —*Providence Journal.*

There is some ground for believing that the next Arkansas Traveler will be a statesman of the name of Garland.—*Phila. Press.*

The people at the telephone: "Hello, Central!" "Hello!" "Give us Cleveland." (Long wait). "Can't raise him; seems to have lost his hearing."—*Utica Herald.*

When Pan-Electric stock was offered to Speaker Carlisle and Sunset Cox they didn't take it. These gentlemen entertain old-fashioned notions about the proprieties which hedge in the conduct of the people's representatives. —*Phila. Record.*

The scandal growing out of this matter—more than that, the scandal which the prosecution of this suit threatens to entail—is a matter of grave importance. Mr. Garland's speculation in telephone stock cost him very little. His stock is substantially a gift. It is a pity that he did not get rid of it before he assumed the high duties of Attorney-General of the United States.—*Newark News.*

Electrical News from Louisville, Ky.

Editors Electrical Review:

Louisville is very quiet electrically. The telephone exchange is under the management of the Ohio River Telephone Company, and is giving fair service. The method adopted here, of placing two to four subscribers on each line, isn't conducive to the best service, however successful financially it may be. But, we may presume, with the subscribers ignorance is bliss; then it is folly to be wise.

Electric lighting is represented here by the United States and Brush systems. The United States people say they are running 300 lamps. The Brush people are doing a small business. In incandescent lighting the United States people are running one or two machines. The United States people have two isolated plants running—one at the *Courier Journal* office and one at the New Grand, doing very nicely, I am told.

When the electric-lighting business was first entered into here two or three years ago, local capital was largely interested, but, through mismanagement and loss, electric lighting obtained a black eye and is now very much in disfavor. The price of gas has been reduced to $1 per thousand by reason of competition, and consumers are very well satisfied in consequence. ANON.

Louisville, Ky., Feb. 6, 1886.

Incandescent Electric Lighting.

(Continued from page 3.)

phous. So much for the carbon filament. The carbon filament has to be maintained in close relation with the rest of the circuit, and various ways have been invented for that. As we proceed then from the incandescent conductor further we come to those parts by which the lamp itself is attached to the main circuit, the holders upon which a great deal of inventive ingenuity has been expended. I will call your attention to the fact that, as far as the glass globes are concerned, there may be any variation of forms in the construction of these globes. They may be pear-shaped or globular. Glass lends itself to any shape, so that that is unessential. But when we come to the vacuum we have something that we have to look at in a much more practical way. A vacuum may be considered as representing so many foot pounds of energy expended. To produce a vacuum you have to lift a column of mercury and allow it to fall, and there it may be interesting to you to know something connected with the vacuum. I am entirely eliminating from view all the delicate refinements of Crookes, Gassiot and so on, because they are simply intended for scientific purposes, and we will come to the discovery of Mr. Sprengel, which will enable you to make as perfect a vacuum as Mr. Crookes made. It consists of a simple tube of glass, in the upper portion of which the object to be exhausted is inserted, and the reservoir of mercury which is allowed to flow into this tube. Those are the elements. I have made vacuo of one-millionth of an atmosphere, and I think you ought not to stop much short of that in producing your vacuum for incandescent lamps. Imperfect vacuo have this quality of conducting a wave of heat more readily; so that if you have an imperfect vacuum you will produce much less incandescing of this carbon-conductor than you otherwise would. And if you would go on adding air to your vacuo you will find that, with the same expenditure of foot-pounds, you have an enormous loss of light; and, if you go still further, as Grove did more than twenty years ago, and fill your globe with other gases, you will find, if you take, for instance, hydrogen gas, that it is very difficult to produce any incandescence of the carbon at all, the hydrogen gas serving there to conduct away the heat with the greatest rapidity. You cannot get your carbon into incandescence without an enormous expenditure of energy. Therefore, to return, we must, in order to produce the most economical incandescence of carbon, have our vacuum as perfect as possible. To produce these carbons it is simply necessary to submit them to the process of carbonization. You are all familiar, I suppose, with the manufacture of charcoal. You take your organic substance, exclude it from air, and heat it. The hydro-carbons pass off, and, as you apply your heat more and more, you get the desired carbon. Charcoal is a very pure carbon. Generally they cover trees they wish to carbonize with earth, set fire to them, and the carbon remains behind as a residum. The same thing is carried on with much greater refinement in the manufacture of these carbons, because you are dealing with things of great tenuity and fragility. They have to be carbonized in certain modes. The carbon I have in my hands shows how remarkable the plasticity of carbon is. I could write my name in carbon if I wish and then carbonize it, and I would get a diminution of the letters, but it would retain its form just as well as if I were writing it in a glass rod. Carbon when heated is plastic, perfectly plastic, and you may tie it into knots; but when it is cold it becomes more fragile. It is, however, very elastic when cold. It is possible to insert into a globe a carbon of very much greater diameter than the orifice through which it was introduced. After all, incandescent lighting points to the use of very long conductors of carbon contained in large globes. It would be very necessary then to put that carbon into such a shape as to diminish the cost of producing your vacuo. Of course, if you can put the same length of carbon into the same compass, it becomes more economical to produce them; but if, as has been invariably the case here, before you have straight carbons, you must correspondingly increase the length of your globe to an extent that I have really seen the matter carried to some extremes. The enormous loss of energy in exhausting those globes is wasteful. If you could have put that carbon into a much smaller area you could have diminished that vacuum considerably more. So that I think I have borne out my statement that, getting the carbons into economical rela, is a very important point to be considered in the manufacture of incandescent lamps.

Now, as to the attachments of lamps, they are various in their nature; and they are matters of detail upon which I will not enter, because all of you, gentlemen, I hope, will look into that subject and present the incandescent using world with nice appliances. I hope to see you take up this subject; and, gentlemen, in closing, I will again revert to the fact that I had no intention whatever of speaking on this subject, but only through the kindness of the President was I induced to give you some views on it. (Applause).

The President—"Dr. Duncan, Chairman of the Committee on Life Tests of Incandescent Lamps, instituted by the Franklin Institute of Philadelphia, is present, and we would be glad to hear from him on the subject."

Dr. Duncan—"I am utterly unprepared to say anything about it, and my knowledge on the subject is very slight compared with Dr. Moses. But it is a subject in which I took much interest, and I have had some opportunities to judge of the life and efficiency of the incandescent lamp. I would say, in the first place, that the tendency has been to increase the tension, and therefore to decrease the size of the conductors. The cost of incande-cent lighting, the great part of it, is in the conductors necessary to carry the very large currents which have been used with the low tension, and lately a great deal of investigation has been made in the direction of increasing the resistance of the conductors. How far the incandescent light can be developed, and how much it will interfere with arc-lighting, of course, we cannot tell. Within the last two or three years some parties have been inventing lamps of great power, which it seems possible will still further be developed to the extent of taking a good part of the street lighting. I do not know how far that will go, but there are a good many difficulties in incandescent lamps, which are very hard to get rid of. After a lamp has been used for a long time, the globe is blackened from the particles of carbon flying against the globe, and that, of course, decreases the efficiency of the lamp. Another defect is, as Dr. Moses said, a change in the structure of the carbon, after it has run for a great many hours. I have examined carbons under a powerful microscope, and find that after a while these carbons, made of natural fiber, become crystalline in structure, and finally, after a few more hours, they go. The most successful carbons, so far made, seem to be of fibrous material. Any homogeneous carbon has, up to the present, lacked the life element. Carbons that have been made of materials that have not had this fibrous structure, have not lasted very long. I do not know whether any lamp has been made, built up artificially that way. But one advantage incandescent has at present over arc lighting is in the greater possible efficiency of the low-potential dynamo. In a dynamo where the potential is not more than 150 volts, the losses are very much less, and, therefore, the efficiency is possibly greater. You have the loss due to the induction currents in the armature; but the loss is less in the low-tension machine, and there is also less possibility of burning out. If you had an arc machine made on the Siemens plan, where the currents cross each other, there is always this possibility of jarring the insulation, when it is run at too great power, and when it is run into very high tension, but with a low-tension machine, of course there is much less possibility of that effect. For that reason, it is, probably, better to have arc machines, with the Cramp type, and incandescent machine with the Siemens type. The latter affords some few advantages for mechanical construction. But I am really not prepared to say anything on the subject, Dr. Moses has so fully covered the ground, it seems unnecessary to say any more."

Dr. Moses—"I hope Lieut. Duncan will not interrupt his remarks on that ground, because he has had great practical experience."

The President—"The Association would be glad to hear from the Doctor as fully as he pleases."

Dr. Duncan—"The work done at the Franklin Institute consisted of tests of lamps and of dynamo machines. The lamps were tested for efficiency, and were afterwards tested for life. Some of them lasted beyond the test. The efficiency tests were made with a great deal of care. The results hardly came up to the expectation of a good many people interested in the incandescent lamp. Mr. Preece made the statement when he was last here that they had lamps in England that would give a candle power for an expenditure of two and a half volts, and yet have very long life. But we found generally that lamps with the greatest efficiency lasted the shortest time. Lamps of long life running into comparatively low tension—lamps of low efficiency usually have long life. There were two lamps which were very irregular. They seemed to be in the experimental stage. They were very efficient, and some of them had very long life, but they seemed experimental, and there were a good many evidences during the tests that the thing was in a transition state. The people were always making changes in the treating of carbons and in the arrangement of details. In most of the later lamps the carbons are very heavily treated by a hydrocarbon. In one make of lamps we tested there seemed to be a very heavy treatment of hydro carbon. The makers would not tell the process. The result of the test to some extent was unsatisfactory; that is, they did not test long enough to put out all the lamps. The lamps were all put in at about the same potential; so we could not judge of the variation of the light with the potential. We could not do it under the provisions of the code which was drawn up. As for the tests of dynamos made after the lamp tests, the only two systems we tested were the Edison and the Weston system. They both are built on about the same principle, of course, and both machines were beautifully finished mechanically. In one machine we tested—a 400-ampere machine, weighing four tons, I think—you could turn the armature around, and it would go around half a dozen times after you started it. These machines gave a very high efficiency, and showed an almost entire absence of self-induction. There was a very small loss due to the pole pieces, and another small loss due to self-induction. But the machines ran with comparatively no sparking—in fact, no sparking at all. We ran the machines for about ten hours on full load, and it took at least ten hours to heat them, and sometimes they would continue during the experiment, lasting about five or six hours. But the efficiency on the different loads was varied a good deal. It seemed that the loss in horse-power was about constant; that is, if it lost two horse-power on a full load, it lost about two horse-power on a half load. Of course, that was a greater percentage of the total power, and the efficiency fell with the small load. But the potential being constant, and the revolutions being the same, the induced currents in the armature would be the same, and the friction the same, and there would be only a difference of self-induction, and it made the loss constant. But I would say, in arc-lighting machines there would be this advantage of having the self-induction very great. In order to get a high tension, of course you have to have a number of windings, and however you arrange those, you have this effect of self-induction. For that reason, one would suppose the incandescent machine would be preferable. There were some criticisms on the tests, I believe, although we did not see them until a day or two ago, about the friction of the armature being very small. The machines were coupled directly to the dynamometer, and in that way all the weight was taken off the bearings, and at the same time the oil was allowed to get all around. Now, the difference between machines run directly that way and run with a belt—there was a pulley on the dynamometer whose friction we obtained after each test; the pulley weighed about 100 pounds, and the friction of the pulley was over a horse-power, while the friction of the dynamometer, the armature weighing, perhaps, 1,500 pounds, was only about four-tenths of a horse-power, due to the fact, of course, that the pulley was pulled up against the bearing, and where it pulled up there was this heavy pressure on it, and the oil could not get in there; while with the armature running with this universal coupling, the oil could get all around it. I think that is all I can say about tests."

Dr. Moses—"Anyone in this Convention who has done work that has value is supposed to offer it here, and if Lieut. Duncan will allow me to put some questions to him that I know he can answer, it may assist that general object. And by the by I will call the attention of the president and the Convention to the fact that I have received a letter from the firm of Woodhouse & Rawson an English firm of some celebrity in the manufacture of incandescent lamps in which they have taken exception to certain experiments made at the Franklin Institute and I would like to have the gentleman answer these questions."

Dr. Duncan—"The first lamps of Woodhouse & Rawson that were put in our hands were marked 55 volts, and we tested them at that potential. Afterward another lot of lamps was sent by Mr. Preece to the Edison Company, and they came to the committee through that company. They were marked 55 volts, but that mark was canceled and 50 volts put there. The lamps were claimed to be 20 power lamps. We tested them and they gave only 12 candles and the efficiency, I think, was one candle to four and a half volts. It was very evident that the lamps were not intended to run at 50 volts. This efficiency of one candle to four and a half volts was such as we did not care to publish because it reflected on incandescent lighting in every way, so we thought that we had better put them in at what we know was the candle-power they were intended for and try them at that candle-power. We considered the matter and put them in at 55 volts, and the committee did not publish the efficiency tests which were made at 50 volts. The matter, I think, was explained by the treasurer of the Franklin Institute in one of the electrical papers."

Mr. Upton—"It seems to me that almost every one who came out behind there is kicking. Now I would like to know what lamp did show the most efficiency and lasted the longest number of hours."

Dr. Duncan—"The lamp that showed the most efficiency did not last the longest number of hours. The lamp that lasted the longest number of hours had the least efficiency. The life of the Edison lamp was satisfactory, but the efficiency was very small. There were two or three lamps that came out very well. I do not like to bring out instances, but if you ask for them I will give them. Mr. Weston says there was a mistake in his lamps, and we were going to test some more but he did not send them in time for the test; but the paper lamps that he sent came out very well in the test. The White lamp of Boston came out very well. In fact all the lamps came out very well. I have not tabulated the results at all and so I cannot say as to them. But no lamp showed both great efficiency and long life. They seemed to part there."

Dr. Moses—"As that is probably one of the most interesting features of incandescent lighting I would like to emphasize to the Convention that those things are somewhat in the control of the manufacturer. As we heard yesterday in the discussion on steam-engines there are some cases where it is better to use high or low pressure, fast or slow run-

ning engines according to the circumstances. The first circumstance that must be considered is that the manufacturer goes in for the object of making money and the one who produces a lamp with the greatest efficiency and the greatest life does not always make the most money. His lamps have to burn out or his business would have to stop. Now they can make them in some respects a great deal better than they do make them, and when the time comes that people will pay a hundred dollars apiece for lamps that last forever, then we will have lamps of perfect efficiency and economy."

Mr. Upton—"The profit seems to be then on the renewal. The report of the Franklin Institute seems to be like these country fairs where they do not want to hurt anybody's feelings and so they give everybody a brass medal."

Dr. Duncan—"The Franklin Institute did not make any remarks about tests. They simply made the tests and let the parties do what they choose."

Prof. Rowland, of Johns Hopkins University, was requested by the president to make some remarks to the convention.

Prof. Rowland—"I have just arrived, and I have not quite caught the drift of the discussion yet. I may say, however, that I have been always interested in this subject of electric lighting, and I remember when I was a student in Troy I used to read about that old Wilde machine which was the first of the modern machines, and at that time I constructed an armature, which, perhaps, some of you saw at the Philadelphia Exhibition. I was too young then to have it appreciated by my friends, or probably I would have had it patented, and it would, perhaps, have been adding to my funds at this time. But my friends did not appreciate it at that time; they thought it was one of the little toys of my youth, so that they let it go. However, I am very well content to be as I am, and to come down here and listen to this discussion. Although I am in the line of theoretical science, I always take a great interest in this subject. When this question of electric lighting came up, I made the first measurements of the efficiency of the incandescent lamp. But the subject has got quite beyond me now, and I do not come down here to discuss the subject at all. I merely came here to learn. I will be most happy to see any of the gentlemen at the Johns Hopkins University. Although our new laboratory is in process of construction, I shall be happy to show them anything we have there at the present time."

Mr. Robinson—"I would like to ask Prof. Moses if he ever found any difference in changing an incandescent—I haven't the knowledge to tell him scientifically what I mean, but I can give it to him on a piece of paper." [The speaker put a question to Dr. Moses referring to changing the poles, which he illustrated by referring to a lamp.]

Dr. Moses—"That has no effect whatever. In fact, you may reverse the poles a thousand times a second without producing any very great disintegration. You can use alternating currents on these lamps, as Mr. Siemens has done. Whether a current flows in one direction or the other through the conductor, there is no appreciable difference that can be observed in any way upon the conductor. The crystallization or the arrangement of fibers does not set in a particular way so that it would be affected by a current running in either direction, so that the results would be absolutely the same whether the current came on the positive or negative pole."

Mr. Robinson—"And then one other thing I would like to ask. I wanted to see what the matter was with an Edison lamp that I have—a lamp hanging down like that [illustrating]—the holder covered clear up with insulating material, and in that lamp there was a large teaspoonful of water. I took that lamp and set it up that way [illustrating] for a month. The water was still in there. I took it and turned it that way [illustrating]. The water was still in there. I put it in the circuit. I got that small arc that we always got in a broken carbon. The water is still in that lamp. From a mark I put on the lamp, by holding it up perfectly level, I can see that it is diminishing. Now what is the cause of that?"

Dr. Moses—"I think it can easily be explained as the way in which the apple got into the dumpling was explained to George IV. All those connections of the Edison lamp are open. Moistures are absorbed by the plaster in such quantity that it became saturated. It dropped upon the heated portion of glass that carried the incandescent conductor, cracked it, and finally it leaked through the crack. It is the only way that can be explained. It is only when the glass was cracked that the water could get in. Experiments were made by Capt. Tanner, of the United States fish steamer Albatros, on the sinking of incandescent lamps at considerable depth, its object being to attract fish to the incandescent lights. He only met with partial success, because none of the globes could stand the pressure at the great depth. But he found that some lamps did leak before they broke. He had lamps made with very thick glass walls, and that was the result of his observation, so that I think the same thing would hold there. When you have a very large crack for the water to come, it gradually was driven in by atmospheric pressure. Recollect that the interior of the globe was in the condition of a vacuum, and when that crack was made the water would enter there freely under atmospheric pressure."

Mr. Hickley—"I think that it is often possible to exhaust the lamp and get it so it will burn very nicely and appear to be a perfect vacuum, and yet there might be a small air space, or crack around the platinum which does not show itself until some time after the lamp has been made. I had, I should think, four or five lamps which, after being sealed in the sockets, I found had got a teaspoonful of water on the inside which could only have come there from the plaster of Paris, as the professor has stated. One more thing I should like to mention, and that is in the shrinking of carbons. Have you ever noticed the difference in the resistance of the carbon, when at a very high temperature, and at a comparatively speaking low temperature? I have found that taking a carbon of seven or eight thousand ohms and treating it with hydro-carbon at a very high temperature, and bringing it down, I would have a carbon which would burn at 150 volts. If I did not roast my carbon to such a high state of incandescence, it would still give the same resistance, but only require 100 volts to bring it to the same candle-power. Upon examining the carbons with a microscope, I found that one was very hard. The other was very much thicker, and yet gave the same resistance as if the two were the same, and yet the electromotive force required was entirely different."

Dr. Moses—"The reason of that is that when you are treating a carbon with a hydro-carbon gas, you do not know exactly what you are treating it with, unless you know exactly the temperature at which the gas is while it is passing in contact with the incandescent carbon. You are aware that all hydro-carbons that are of definite composition have different proportions of carbon and hydrogen in them. The higher the temperature to which that hydro-carbon is submitted the more carbon remains behind. Those who are acquainted with petroleum manufacture will know that there is a residuum left, and you may carry that thing as I mentioned to M. Dumas, to an extreme, to a point where the carbon will not stand any more heat. That is where an ordinary incandescent lamp will come up to 150 or 200 candle-power, and then there is a disruption of the carbon. I am safe, I think, in assuming that there is no carbon, with the exception perhaps of the diamond, that does not contain hydrogen in it. Now, as you heat your gas you are driving off more and more volatile properties, so that you are reaching a point where there is more carbon in the gas than there is hydrogen; that is at a lower temperature. These highly heated gases you speak of deposit a more dense carbon on that account."

Mr. Smith, Jamestown, N. Y.—"I would like to ask Dr. Moses if the life of an incandescent lamp, run on an arc circuit from a high potential, is necessarily shorter that the light of an incandescent lamp run from an incandescent machine, and if so, why?"

Dr. Moses—"There is only one reason, because lamps to be run successfully should be run at uniform potentials. A lamp can only bear a certain amount of current. It is calculated for that, and should be invariably run at that. If a man had regular habits, and goes to bed at nine and gets up at seven, and does not have any moral or religious or political troubles in the world, he will live a very long time. So with an incandescent lamp. But an arc light is a curiously and wonderfully-made thing, and if you observe incandescent lamps on arc-light circuits, you will find them running at a much higher electromotive force than they ought to run. This very subject that was brought up before, of the deposition of carbon at high temperatures can be brought to apply to that. You heat the carbon to a much higher temperature than it was intended to bear, to a point at which it loses some of its hydro-carbon substance. Then it becomes less in resistance. There is more current passes at that point, and in that way you disintegrate the lamp, and destroy it. If you could afford to have an apparatus such as that seen last evening in the president's rooms [the Brown Automatic Converter], where you have a series of arrangements of incandescent lamps—and you can by throwing in corresponding resistance in case of the destruction of one of those lamps—you can compensate for it, and keep the lamps at a constant electromotive force. In that way it would be possible to run incandescent lamps in arc-light circuits. I would like to call the attention of the members to that apparatus upstairs. It is made by a capable young man, Mr. Brown, and has some meritorious points about it."

Mr. Smith—"I am running incandescent lights on an arc-light circuit. They are controlled by a Brush Automatic Cut-off, which is very efficient, so far as it goes. The current is so steady that you cannot see by the eye that there is any difference in the lamps. What I want to know is whether there is something in the nature of the high potential current which destroys the lamp sooner than the low potential current. I think that the objection you raise is easily understood, but in our case it does not apply, because the lamp does not flicker. If one breaks, the cut-off goes into operation. I cannot see anything else in it, so far as the nature of the unsteadiness of the current is concerned. There must be something more besides that."

Dr. Moses—"I presume that it is due to the fact that there is a greater pitch to the electrical wave, if I may be permitted to use that expression. If you are using a current of high electromotive force, your carbons become highly incandescent, and there are variations that are imperceptible to the eye; but, that those changes take place, I think is theoretically quite possible. The carbon is in a plastic condition, and is heated to enormously high temperature. It is in vacuo; consequently the radiations are not so rapid, and any changes of the kind, I think, would not be so very serious, because the temperature of the carbons would not change rapidly enough during the intervals in those operations to bring about that disintegrating effect. It is a curious phenomenon. It takes time, however, to discuss it. Is it your experience that those lamps do not last as long as those that run on lower potential machines?"

Mr. Smith—"My experience is that they are very short, indeed. My experience in incandescent lighting on arc-light circuits has not been a profitable one. In one case we burned out fourteen lamps, at a dollar a piece, in one month, where our income from those lamps was six dollars a month."

Dr. Moses—"At the last meeting I called attention to the fact that I did not think that up to that time there had been a sufficient advance made to induce people to introduce incandescent lights on arc-light circuits. I deprecated it, because the arc had not sufficiently advanced. You are dealing with very high potential currents, and you are using very delicate bridges, and why should you charge the whole of your current through those small bridges, if you can get light economically in any other way. I think it injures both the arc light and the incandescent light business to do it. Anything that prevents the light from being constant is doing an injury to our electric light interests. A very slight shock can paralyze an incandescent light. You shouldn't take so delicate a piece of apparatus as that, and put it on a current of such enormous proportions, unless you have a perfect regulating machine."

The President—"Mr. Swift, of the Brush Electric Light Company, of Cleveland, is present, and I think that company is the one which inaugurated the system of putting incandescent and arc lights on the same circuits. Perhaps he can answer the gentleman's question. Mr. Smith, of Jamestown, N. Y., asks for reasons why incandescent lamps on an arc circuit burn out far more rapidly than those on a circuit run from an incandescent machine, and he makes the statement here that, in one case where the income is six dollars a month, he burned out fourteen lamps at a dollar apiece, and so he thinks that there must be something radically wrong, which may possibly be remedied."

Mr. Swift—"The company that I am connected with does not furnish the lamps. I should have to refer you to the Swan Lamp Manufacturing Company."

Mr. De C. mp—"I wish I could get out of my scrapes as easily as that."

The President—"That is true, and sounds very well to the gentlemen present here who are not subordinate companies of the Brush Company. The officers of the Swan Company are the officers of the Brush Company. The Swan Company is in the Brush manufactory. The difference between the Brush Company and the Swan Company, in Cleveland, under my observation, was a partition of pine boards an inch thick."

Mr. Swift—"In reference to what you state I will say that the main point is that it lacks the elements of truth. The officers of the Brush Company and the Swan Company are not the same. Mr. Stockley, who was manager of the Brush Company, is not even a director of the Swan, and I am not even a director or a stockholder of the Swan, so I cannot be expected to answer the question."

The President—"I only want to add here that all the orders that go from our company for Swan lamps go to Mr. Swift."

Mr. Swift—"If you send the order to the Brush Company they will receive it as a matter of courtesy to you and turn it over to the Swan Company."

Mr. Smith—"I think I ought to say that the lamps vary a good deal in quality. Some of the first lamps we got lasted much longer. I do not think it is due to inequality of the action of the machine. There is no fault to find in the current of the machine. The cushioning arrangement of the machine certainly does keep the current steady, so that we have the point of our ampere meter at one all the time. If it lags a little bit in action the man assists it."

Dr. Moses—"I would like to mention to the gentleman that, according to the highest authority, Professor Helmholtz, the eye is a very imperfect instrument; and, in the second place, if you wish to see how quiet and calm the effects of a disrupted current are, take any of the Geissler tubes and you will see *stridae* absolutely motionless; and yet we know that the current is being disrupted hundreds of times a second. So that the eye is no instrument to be used as a criterion."

Mr. Smith—"Is not the ampere meter reliable?"

Dr. Moses—"Not at all. I am quite sure that we could receive considerable instruction and delectation from Professor Rowland on this very subject, if he would give the convention some idea of the methods that he employs for registering variations in currents."

Mr. Morrison—"I would like to ask Dr. Moses and Prof. Rowland whether they agree with the statements made by Dr. Duncan that all lamps come under one rule, namely, that

a lamp, by whatever it was increased in efficiency, was diminished in light?"

Prof. Rowland—"The theoretical efficiency of a lamp depends only on the temperature. It makes no difference what the shape of the carbon is, or anything of that sort. It merely depends on the temperature at which the lamp is heated. For instance, you can very readily, from the distribution of heat in the solar spectrum, determine what the efficiency of the lamp would be. I have done that. I have not got the figures here now. I calculated it at one time and it came out a very high efficiency indeed; because when the current passes through the carbon the heat is generated in proportion to the energy of the current. The heat is radiated out in the form of both light and radiant heat, and the greater the proportion of light is the more efficient is the lamp. Therefore the higher the temperature the more efficient the lamp is; and, so far as that goes, it makes no difference whatever with regard to the kind of lamp; it only depends on the temperature of the carbon. At the same time, it is possible with some other substances besides carbon to radiate more light in proportion to the heat. I cannot say but what by coating the carbon of the incandescent lamp with some substance—I would not be able to suggest what it would be—it might be found by experiment that the efficiency of the lamp might be increased. I know of no such substance. Nearly all substances become red hot at the same temperature. I do not know any substance which becomes red hot sooner than another substance. In ordinary physics it is stated they all become red hot at the same time. If that is so, it is to be supposed that the proportion of radiant light and heat would be about the same. If that is so, the efficiency of the lamp would only depend on the temperature But I think very likely you might find some substances which, by coating the carbon with them, you might get more light."

Mr. Upton—"I am not an electrician. I am glad I am not. But I had a little experience in Washington looking at these things. I have yet to find any success financially in any incandescent lights, running off arc-light circuits. I talked with both the Brush and Thomson-Houston people. If you examine a bamboo fiber, and get a cross-section of it, you will find that it has ten fibers. In the manufacture of the incandescent lamp those fibers are divided, because they are not absolutely parallel. Now, if in the process of dividing those fibers you cut some of them, why, you discover that the resistance of that particular lamp varies from the normal. It is very reasonable, too. Just imagine it to be ten wires joined together. In the process of shearing you may cut those wires and you have only little wires left, and so on. When you have, in order to increase the commercial efficiency of the lamp, brought it down to the small dimensions, you have there only five or six wires to conduct the current. You have diminished it by one-half, to be sure, but you have also cut one of those fibers. That relation in the first case is as one to ten, in the second as one to five; so that the mechanical difficulties being overcome, you are increasing the efficiency of the lamp by diminishing the diameter of the conductor. I simply say that in explanation of what Prof. Rowland has remarked, because it might lead us to think it was simply a question of temperature. He is perfectly correct in what he says. He assumes a perfectly homogeneous conductor."

Prof. Rowland—"I was not speaking with regard to the life of the lamp. I was speaking with respect to the amount of light we are getting from a certain amount of electrical energy, and my remarks were perfectly exact in regard to that. Of course the question with practical men is to find an element that will stand the highest temperature for the longest time. That will be the solution of the problem."

Mr. Morrison—"That is the question I asked, if you will allow me. By however much you add to the efficiency of the lamp you decrease the duration of the lamp."

Prof. Rowland—"That would naturally be so, because if the efficiency is higher the higher the temperature, and of course the carbons will not stand it. It stands a low temperature very well, and the higher the temperature the less it will stand; so that in all cases the higher the efficiency the less time the lamp will last. At the same time of course one cannot say that a paper carbon would not last longer or shorter than a bamboo carbon. I suppose it is a question of experiments which of those carbons would last the longest. I think that the true method would be to test with a lamp so as to give the same efficiency in all cases."

Mr. Ridlon—"I would like to ask the gentleman one question. I have noticed in some incandescent lamps that the lamp goes out instantly when the carbon is destroyed; in others the lamp is blackened up. I would like to ask the question whether that is a different kind of carbon. Is one carbon more apt to do that than another?"

Prof. Rowland—"I think that it would depend very decidedly on the kind of carbon, because carbon varies so much from the soft charcoal down to the diamond; and it evidently would depend upon the degree of hardness or possibly the amount of gas that remains in the globe. That evidently plays a very important part in the light of a lamp."

Mr. Ridlon—"I have noticed in an Edison lamp particularly that it lights up for some time before the carbon is destroyed."

Prof. Rowland—"That I understand is one of the practical disadvantages of all these lamps. It may possibly be gotten rid of at some time."

Mr. Kerr—"I am not a light-maker or an electrician; but there is something that has come up here that is very interesting to me. As I understand it, it is stated that the life of an incandescent lamp, providing the carbon is homogeneous, is chiefly proportioned to its temperature."

Prof. Rowland—"Well, I suppose that the temperature of the fiber would not be the same everywhere, if it was not homogeneous—assuming that the temperature of the fiber is the same everywhere."

Mr. Kerr—"The point I wish to make is simply this: If as we go on increasing our temperatures in carbon, we find we are getting a shorter durability of this carbon, suppose we do that for 2,000 degrees. That does not establish the law, that if we went to 3,000 degrees it would be still less durable. I wish to relate a little thing in the process of steel manufacture. In the casting of steel ingots it is necessary to use something to prevent the sinking of the ingot. The thing that is used is white hot charcoal. Charcoal is put in a graphite crucible, is heated up to absolute whiteness, and when that is done it is hermetically sealed and when that is heated you can kick the cover off and just turn it over like white hot sand. Now, I was at a steel works one day when they had just had an accident. They had turned a graphite crucible and they knocked off the cover and two men were injured. The carbon in the crucible seemed all to go instantly out. It was heated to 1,200 or 1,500 degrees. That is about a good redness I believe. Up in the neighborhood of 3 000 degrees the carbon will not ignite with air. You can see all you want of that right there every day. Now it is not fair to assume that carbon heated to an enormous temperature is necessarily more combustible; because there is the case where the softest carbon we have at a very high temperature does not combine with the air. Consequently I would not admit that the life of a lamp was increased by raising the temperature beyond a certain point. The probability is that we have another outgrowth of carbon at that point."

Prof. Rowland—"I would like to inquire how he got the carbon at that temperature. I supposed that heat was generally produced by the burning of carbon, or perhaps the gas. Of course, one might possibly get it at that temperature by putting it in the sun perhaps. I imagined that the temperature of ordinary furnaces was produced in that way."

Mr. Kerr—"You simply wish to know how we got the carbon heated. Simply in that steel furnace; it is put in a graphite crucible; I am not saying anything definite about temperatures; I am only assuming certain temperatures. It is white heat, however, and as I understand, that is about 2,500 degrees."

Prof. Rowland—"I do not suppose that that is a point in electric lighting, because it is a fact, I understand, that the higher the wires are heated the less time they lost. I supposed that was an accepted fact in electric lighting, the higher the temperature you get the carbon the less time the lamp will lose."

The President—"I think Mr. Kerr means to say that in the one case the pulverized charcoal when brought up to a red heat, when the crucible was opened at red heat, that the carbon passed off in the dust."

Mr. Kerr—"It just ignited with the air."

The President—"Just went off the same as a filament in a lamp. Now he goes on to say when a greater heat had been reached, a white heat, that instead of it passing away that you could take a spoon and could handle it in that way, and no perceptible change would take place, and he draws the inference: may the ground that was heretofore accepted as the proper one—may not that be an erroneous ground; and the extreme heat which produces the greater efficiency of the lamp, may not that be a mistake?"

Mr. Kerr—"Yes, sir, that is it exactly."

Dr. Duncan—"I said that with the lamps we tested, those of the greatest efficiency had the shortest life; but if that were true, of course, generally, then there would be an end to improvements in incandescent lights; because you would have to sacrifice one or the other. With the same lamp the life depends entirely on the current used, and the light increases very rapidly as you increase the current. As far as different kinds of carbon goes, if you increase the temperature it has to go through, the form when it becomes crystalline, and at that point the carbon will give way."

Mr. Woodbury—"In regard to the difference of the structure of carbon at very high temperatures, Mr. Edison made some investigations upon that point by putting a screen in the middle of the horseshoe of the Edison lamp, and where the current was running through the filament, noted the deflections of a galvanometer, showing the difference of an electrical connection between one of the wires to the lamp and the wire from the platinum screen in the middle of the lamp, and he increased the current with increments until the lamp got up to something like 30 candle-power, and then the deflection would diminish, seeming to be a reversed condition. Mr. Edison, at the time of showing it to me, advanced the hypothesis that it was quite probably due to the fact of the carbon changing in that temperature from an electro-positive to an electro-negative substance. In regard to the question of the plastic state of the carbon in the crucible, is it possible it was heated up beyond the point of temperature or dissociation? Was it heated by a gas flame containing a great deal of hydrogen, and therefore hotter than the carbon?"

Mr. Kerr—"If you stopped the carbon during this process of heating at any time before it gets to a certain temperature, which I cannot fix, but we will call it 2,000 degrees, no one particle seemed to wait for another. But when you have it all heated and then cool it down, it will cool down past that point and not make any fuss about it at all. There is this, however, to be noticed in that white-hot carbon, as you look at it in the crucible, every little while one little particle will ignite, and you will see a little spark that will go about twelve inches. Wait a little and you will see a little flickering from the top as if something else than carbon was being consumed. But the body of it is all there."

Dr. Moses—"It is an exceedingly interesting discussion, because in a collateral way it demonstrates the fact that if carbon is heated, it diminishes in proportion to the increase of heat, according to a regular increment. The ordinary carbons, such as are used in incandescent lamps, shrink about one-third of their length."

Prof. Rowland—"I am not a chemist, but I believe there are three forms of carbon; the ordinary charcoal form, the graphite form, and the diamond, and when one heats the ordinary carbon at ordinary temperature, it is different from other elements in its specific heat. But when it is heated up to a very high temperature, indeed, it commences more and more to obey that law, and therefore there is a very marked change at that high temperature in the carbon. I do not know what bearing this has on the life of a lamp, because I do not know which form of carbon would last the longest; but still it must have some bearing."

Mr. De Camp—"I think that this question of incandescent lighting on arc circuits is one of the crazes we have got to submit to. It is new, and no electric lighting company can speak, except from a very short experience. It is a sad one from all that I hear of it. It is so with me. It results in this, that it is going to make a very lively business for the lamp manufacturers. The gentleman raises a question as to the breakage. I wanted to ask Dr. Moses, but I did not want to interrupt him, what would be the difference in the potential of an arc machine by increasing the revolutions, say three or four or five in the armatures, or what would be the effect of an increase of, say ten volts, on a group of lamps on a circuit, that is so far as potential is concerned. We group our lamps according to the current of our machines. We do know that in a group, say of seven—"

The President—"One moment, Mr. De Camp. To make that plain, the machine which Mr. De Camp uses is the 26-inch armature new type of Brush machine, and upon that armature an increase in the number of revolutions in the armature operates to produce a much more marked result than in one of a smaller diameter."

Mr. De Camp—"We do know this: If we have two, if we have one out of a group of seven that goes out from any cause, the others brighten up away beyond their normal condition, and we must get something in as quickly as possible to take the place of the exhausted lamp. That is done, and perhaps few lamps follow the breakage of that one, on account of the comparatively perfect operation of the cut-out that we use. But if we strike off two of them, or three of them, the rest will go instantaneously. Now, it is, no doubt, due to the fact that we are driving through those lamps that remain the full force of our current. I do not think that anybody can have any question about that. It is easily demonstrated on our circuits. But to run a dynamo machine for a number of hours, without having a chain of say twenty volts, if you choose, in the electromotive force of that machine, by the increased speed of your engine, or decrease of it—now, I would like to know what difference that 20 volts would make on that series of lamps; that is the 20 volts above the normal condition of the machine. Do I make myself clear?"

Prof. Moses—"If you crowd your cars, you are bound to have accidents. Your difficulty is that you break some of the avenues, the indispensable avenues, for the passage of the current. If you diminish the resistance of these bridges, you will throw such enormous amount of work on the fibers that they won't stand it. To obviate that, you must interpolate some independent resistance, which will be thrown into action by the breakage of one of these girders. You must do that; otherwise your current will put an end to itself in a very few minutes, by the disruption of all carbon avenues."

Mr. De Camp—"That is my idea about it, and I do not think we shall be able yet to run a dynamo machine with such absolute perfection, and keep so perfectly on a level for supplying those lamps, that with the best form of cut-out that you can put on it can act quick enough to protect the lamps against that instantaneous action that must take place when one goes out. I do not believe that can be done. It is a scientific point, and it is Greek to me. The incandescent light is popular. It is growing in popularity. It is most popular among the business people. For certain purposes the arc light suits them; they have no objection

to it. There are certain places where they have gas, and where they have no earthly use for an arc light. The distribution of the light to their offices is a great advantage to them. Its freedom from heat, and all that, is taken into consideration, and they are pleased with it. But, like everybody else who gets hold of a new thing, and who is highly pleased with it, they don't think much, at the time, of the expense, but when the novelty has worn off I contend that the public will not pay the price that we have to charge for it if we are going to get a profit out of it I will explain myself in this way. After the romance and novelty of the incandescent light has worn off, it is simply a substitute for gas light. Now at present the price of gas, as compared with the incandescent light, is very much less. But I think that people would be willing to pay a reasonable increase over gas. We had a little installation that was entirely in our hands, and so understood by the parties using it. We agreed to make renewals. We agreed to do everything. Now, that has been an expensive job. The proper way to have done that would be for the user of the light to have paid for his renewal of lamps, for two reasons: If we had those lamps in there, why, they would say, 'Let it go; it doesn't cost us anything.' If your lamps are in a business place where there is a lot of boys who get to meddling with them, they destroy your property, because there is nobody in the interest of the property to look after them. But if it is a man's own property, they will watch it carefully."

Mr. H. W. Pope—"I have in mind an experiment I tried in Brooklyn. I inserted an adjustable resistance in the main arc circuit, and from that I ran a shunt wire, and connected my incandescent light from the shunt wire to the arc in that way, taking the incandescent lights entirely out of the circuits. That is to say, it would shunt the current, and only a portion of the current would get into the incandescent lights. It seems to me that the life of an incandescent lamp connected that way would be much greater."

Dr. Moses—"I think if it were possible to introduce the incandescent light on arc-light circuits, it would enormously increase the volume of business done by the electric light companies. Therefore, I think it is a thing of vital importance to determine whether it is possible to introduce incandescent lights on arc-light circuits. Mr. De Camp says that the consumer should supply his lamp. Let us briefly consider some of the difficulties in the way of that. The consumer must get lamps of a certain electromotive force. He buys them from the company, who may or may not guarantee them He puts them in a circuit, and his lamps may be destroyed. Therefore, it is to the interests of the arc light company to supply those lamps, and in that way to avoid that difficulty. However, let us assume, because I think it is very near solution, that the problem has been solved, and that you can put incandescent lights in arc-light circuits. Let us consider what the cost of an incandescent lamp is, roughly assuming that it will burn a thousand hours at a cost of one dollar, which will make the cost of an incandescent lamp one mill per hour."

The President—"One mill per hour provided the lamp lasts a thousand hours."

Prof Moses—"Yes."

The President—"The life of a lamp, Mr. Smith, of Jamestown, claims, is not a thousand hours."

Dr. Moses—"But I assume it is possible to keep the electromotive force of an arc-light circuit constant. I have taken a dollar as the cost of a lamp, in order to give one mill. Now the cost of the incandescent lamp for renewals is one mill. May I ask Mr. Weeks, at this point, what is the cost—I think you had seven per cent., Mr. Weeks—of supplying carbon? What is the cost of maintenance and attendance and putting in of carbons?"

Mr. Weeks—"No, sir; 28 per cent. was the total cost of carbons and globes."

Mr. De Camp—"You are speaking now of the cost of carbon alone."

Dr. Moses—"No; the cost of maintaining that light in a state of efficiency. The carbons, globes, wires—all that to be eliminated in case you have an incandescent light. Twenty eight per cent. on the cost of maintaining an arc light. If, for instance, to make it more complete, you charge eighty cents for the use of an arc light per diem, for what would you be able to afford to supply that arc light in case you were not called upon to maintain it?"

Mr. De Camp—"Aside from the carbons used in an arc lamp, the cost of attendance on it, that is the trimming of it and the keeping it in repair, as it is on the circuit, the cost of the extraordinary repairs to the lamp by occasionally burning out, something of that kind—take that off of the original cost; then all the rest of your expenses on the group which takes that lamp's place are the same. Hence that would be the cost."

Mr. Cooper—"I wish Dr. Moses would take that at twenty-five per cent."

Dr. Moses—"Assuming that 80 per cent. is the cost of an arc light per diem and that you save twenty-five per cent., that would reduce the cost to about sixty cents per diem. Now, will some gentleman inform me how long an arc light will burn under those circumstances?"

Mr. De Camp—"I would take that on the basis of eleven hours and a-half."

Dr. Moses—"Eleven hours and a-half for forty cents. That is about three cents and a half, then, per hour, as the cost of the arc light. You would be receiving three cents and a-half per hour for your arc light if your consumer were to take it and burn it for eleven hours and a-half. Therefore his light would cost him three cents and a-half. Now that is a pivotal point. Three and a-half cents an hour would then be the cost of maintaining about eight incandescent lamps of sixteen candle-power. Three and a-half cents for a group of eight—let me say four cents; four cents as the cost of eight lamps burning eleven hours and a-half."

Mr. De Camp—"Take that eleven hours and a-half, or four times eleven and a-half, that is forty-six cents, that we would have to charge this customer for these lights."

Dr. Moses—"Well, I beg pardon there, because you are told to take off twenty-five per cent. and you would then be making the same profit and you would have no trouble. Therefore I think that the thread of my argument you must admit, because it is something that is quite evident."

Mr. De Camp—"Take off the twenty-five per cent. for that."

Dr. Moses—"You would be able to have sixty cents to supply the lamp to a consumer."

Mr. De Camp—"It is four cents an hour for a group of eight, and we run eleven hours. That would be forty-four cents. That would be on an even basis with an arc plant."

Dr. Moses—"Now you have eight lamps for four cents per hour."

Mr. De Camp—"Figure that up at $1.50 a thousand."

Dr. Moses—"Seventy-five cents is the cost of gas to the consumer and he is getting the equivalent of that for sixty cents. Now one mill per hour per lamp is ten cents. Ten cents and sixty cents is seventy cents. He would be getting for seventy cents his incandescent light which he would have to pay seventy-five cents for in gas. Now gentlemen, I hope you will observe those figures so that you may go over them yourselves."

Mr. De Camp—"I am not taking this on the limited number of cases where that business would be demanded and where people would pay the price which might be profitable to us. That is the case—"

Dr. Moses—"Here is the difficulty, that compels the consumer to use those incandescent lights all the time. Now, then, how many stores and places are there where you can use groups of eight?"

Mr. De Camp—"I do not think that there are many. I think the business is a very limited one indeed. You can sit down and convince a man that it is the cheapest light in the world, but after a while the novelty gets worn off. He admits what you say, but he says, you have given me more light than I want."

Dr. Moses—"You must come to the point where you supply that as long as he wants it and no more."

Mr. De Camp—"If we could run directly, as a gentleman here said to me, with each lamp having its own resistance. Now we can take a fifty-light machine, for instance, and particularly if we can work on the principle of an electric lighting station on the incandescent—assuming that you have got 5,000 lamps out, yet there is no probability of more than half burning at one time. We can take a machine and put out from that 500 lights. We have a meter on that machine and know that there has been a judicious distribution of those lamps, where people could save something by switching off a light here and there, that doesn't pay in gas somehow. [Laughter.] However, I like that sort of business first-rate, if we could get it in such a shape that the less we used the bigger our bills would be. That I conceive would open a big field to the business."

Dr. Moses—"It may be possible to construct so many incandescent lights that some day we may include forty or fifty houses in one series with a proper automatic arrangement. But until those arrangements are perfected, we cannot put a series of incandescent lights through a variety of houses."

The President—"The time is past now for the discussion of this subject. Mr. Ridlon will present his report on "Carbons and Globes."

Mr. Ridlon said: "I will say in regard to this carbon business that I have sent to every prominent electric-lighting company for recommendations in regard to tests of carbon. I have not been able to get any positive facts or statements from any of them. I had to go to work and make up this statement from such raw and crude materials as I could pick up myself, and I would be very glad to have this thing come up here and be fully discussed by the superintendents and managers of the electric-lighting companies themselves. They, of course, all have different machines, giving different amperes of current, and they certainly would require different tests for their apparatus to make it perfectly satisfactory to them. The whole question seems to come down to this, that in purchasing our carbons we want to get one steady average quality of carbon, and we want all we buy, whether ten or twenty or thirty thousand pounds, or whatever the quantity be, to come up to the standard of the quality which we supposed we were purchasing at the time we made our arrangement with the dealer or the agent of the carbon company; and I think that the greatest trouble that we have experienced in the matter of carbons is due to inattention in the sorting of carbons where they are manufactured. I think they have simply taken up a carbon, rolled it out on a piece of smooth iron. They have employed the cheapest class of labor in their manufacture, simply boys and girls, and assorted them with the idea that carbons that were straight were used for firsts, and carbons that were not straight were used for seconds. It does not seem to me that that is the kind of assorting of carbons that we require. We want to be sure that all the carbons we purchase at a given price possess all the requisite qualities; that is, that there are no soft spots in them; that they are of the average amount of resistance, that is, that we can get our full complement of lamps, giving the proper amount of candle-power on those lamps from the machine less the distance of the wires, it would be according to the length of the circuit. And, in order to bring this thing up, I would suggest that this matter of seconds should be cut down to such a price that in making our contract it will be quite an object in sending carbons that they were all of the first quality, and no seconds were mixed up with them; and if seconds were mixed up with them, that the price would have to be reduced for the second quality of carbon; that they would rather pay a good price for labor and get competent persons to do their sorting. I should be very glad to hear from the carbon men on these suggestions. We all know very well that the kind of carbon that will do for one purpose will not answer for another, and the carbon that we might use economically in the summer we certainly could not use in the winter.

"This matter of globes was also to be reported on. But I do not see any report that could be made on that. It is simply this, that in a certain place where you did not require a very bright light, you might use an opal globe to obscure the light. In another case where you want all the light you could get, you might use a clear globe; and in another case you might use a half ground globe. I expected Mr. Gregory of the Union Glass Company here to take up the question with regard to the proper materials for making globes. As he is not here, I hope Mr. Libbey, of the New England Glass Works, will give us some information on that subject." (Applause.)

Mr. Morrison—(Mr. E. R. Weeks, vice-president, in the chair.) "The question of carbon is a very important one to the electric companies, and by great competition the price has been reduced from $66.50 down to the lowest figure quoted in the market to my knowledge, $10 a thousand. This was owing simply to the sharp competition which had been engendered by the enormous profits made by the Brush company when they first put the carbons on the market. The first break was made by Mr. Boulton, originally an employe of the Brush company, who, after serving with them for a certain time, and observed the enormous profits that were made in that line of business, fairly presented the subject to the enterprising capitalists of Cleveland, and induced them to establish a rival carbon factory. The establishment of this factory has made Mr. Boulton a benefactor of the electric light companies. Following this break came a number of other small manufacturers, so that we are to-day supplied with a ten-dollar carbon instead of a $66.50 carbon. The information that Mr. Ridlon has gathered together, and which I am sorry I did not hear the whole would leave one to believe that the difference, in the quality of the carbons is as great as the difference in the manufacturers. Is that right?"

Mr. Ridlon—"Yes, sir."

Mr. Morrison—"That is not so. We have used the carbons manufactured by the Boulton company, by the Pittsburgh Carbon company, by the Parker-Russell Manufacturing and Mining Company, the Brush, of course, and I think one or two others. Nearly all of them have given fair satisfaction in our service. The proof of the pudding is in the eating, they say, and the proof of this statement I am making to you lies under your observation every night that you walk the streets of Baltimore. There are the lights, and there are the carbons which we are using to-day. We do not mix the carbons of different manufacturers upon the same circuit, because that would not be giving fair play. The defects in a lamp might possibly be attributed to the carbon itself when the carbon would be all right, but if you take an entire circuit of lamps and equip them with Brush's carbon, and right along the streets here where our wires interlace, one lamp is on our No. 1 circuit, the next on No. 2, the next on No. 3; so you get four or five squares before you strike a lamp on No. 1 circuit. An entire circuit is devoted to the use of carbons of one maker. That man is going to get more fair play than if you mix him up with two or three other makers. There is one thing which will transpire within the next twelve months, and it will be to compel fair play not only in carbons and globes, but in the matter of machinery and other supplies used by the subordinate companies from the parent companies from whom the apparatus and supplies have been obtained. (Applause.) You will observe that that applause comes from points where there are no electric light companies represented.

"I do not know that I can add anything further to the question of carbons. As to the matter of globes, we have found a difficulty in obtaining a sufficient degree of promptness in supplying our orders for globes, and for this reason, then, we have bought globes from almost every manufacturer within our reach in the United States. Our principal purchases have been made from the New England Glass Company, and I am glad to say we have received a fair quality of goods and fair treatment from that company. When troubles have arisen with their goods, they would hasten to rectify them. When a change in the form of a globe was needed they would hasten to change the form of the globe. So that of the globe men, we have not such serious complaints to make as we have of the carbon men."

Mr. Ridlon—"I have listened to Mr. Morrison's statement, but still it does not cover the ground on which I based my report on carbons, which is simply this: that I would recommend that the electric lighting companies would adopt a test, or discuss here what would constitute a fair test for the carbon, which should be known as the standard carbon; that we can arrive at some point where we will make our proposition to the carbon manufacturer of what we require. The other part of my argument in regard to taking seconds, was simply a question of compelling them to live up to their agreement. I do not know what your experience is, but I can answer for the experience of the Brush Electric Lighting Company, of Boston, that the poor quality of carbons is one of the most expensive things about the business. That is, the deduction on monthly bills for electric lighting, when added up together—perhaps a light goes out before half an hour, owing to a defect in the carbon, or a soft spot in the carbon; the price of that light may be seventy-five cents for that evening. That seventy-five cents is deducted. Perhaps that light may go out four or five times in a month. That is seventy-five cents for each day. Now, taking that in seven or eight hundred nights and add that to the price of the cheap carbon, it will bring back the cost of carbon to the old price of sixty-five dollars, before you know it almost. Then added to that is the annoyance of complaints from the customers, and the general discredit of electric lighting.

Mr. Fishback—"The way in which Mr. Ridlon puts the question seems to me to give to the electric light superintendents a good deal of leeway, and there may be some superintendent not as conscientious on the quality of carbons as Mr. Ridlon would probably be. I believe that carbon manufacturers in general are disposed to do the fair thing. After an electric light company gets fifty or a hundred thousand carbons, and finds they are not up to the standard, and then refuses to pay the price it puts the carbon manufacturer in a bad light, where he was disposed to do right thing, and where the superintendents of lighting plants might not be conscientious."

The Chairman—"I will appoint on that committee Mr Cooper, Mr. Ridlon and Mr. Fishback."

Mr. Barclay—"I do not think that it is right that any carbon manufacturer should have a voice in determining the standard."

Mr. Cooper—"The point is well taken."

The Chairman—"I substitute Mr. King."

This committee on carbons recommended the following as the standard test of carbons:

Take a dynamo, with its full complement of lamps, with the same make of carbons; note the speed of the dynamo carefully, and during the test measure the current at frequent intervals with an am-meter; see that all the lamps burn freely, without hissing, and yet not with so long arcs as to flame. Measure the E. M. F. around each arc with a volt meter. Burn the lamps until all the carbons are consumed, or burn them, say for four hours, and then measure the length of carbons consumed, and calculate the total time that they would burn, taking the average result.

Mr. Ridlon also moved that a committee of five be appointed to raise funds for carrying on a bureau of electrical information, as provided in a former resolution The motion prevailed, and the chair appointed Messrs. Ridlon, of Boston; Corby, of St. Joseph; Price, of New York; Martin, of New York; Bowen, of Chicago; De Camp, of Philadelphia; Cooper, of Brooklyn; Goff, of New York, and Cleveland, of Hartford.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING FEB. 16, 1886.

336,081 Transmitter for electric telephone lines; Chichester A. Bell, Washington, D. C.

336,082 Jet microphone, or apparatus for transmitting sounds by means of jets; Chicester A. Bell, Washington, D. C.

336,083 Telephone transmitter; Chichester A. Bell, Washington, D. C.

336,087 Armature for dynamo-electric machines; Chas. F. Brush, Cleveland, Ohio.

336,095 Individual electric signal; Arthur W. S. Davis, Lowell, Mass., assignor to Frederick Taylor, same place.

336,101 Composition for secondary battery electrodes; Ernest M. Gardner, Brookline, assignor to James L. Little, Jr., Boston, Mass.

336,102 Electrode for secondary batteries; Ernest M. Gardner, Brookline, assignor to James L. Little, Jr., Boston, Mass.

336,132 Electric meter; Samuel D. Mott, New York, N. Y., assignor, by direct and mesne assignments, to the Schuyler Electric Light Co., of New York.

336,133 Electric meter; Samuel D. Mott, New York, N. Y., assignor, by direct and mesne assignments, to the Schuyler Electric Light Co., of New York.

336,173 Telephone transmitter; Sumner Tainter, Washington, D. C.

336,176 Electric arc-lamp; John Tregoning, Brooklyn, N. Y., assignor to the Schuyler Electric Light Co., of New York.

336,184 Electric arc-lamp; Addison G. Waterhouse, New York, assignor, by mesne assignments, to the Schuyler Electric Light Co., of New York.

336,191 Switch and holder for incandescent lamps; Merle J. Wightman, Hartford, Conn., assignor to the Schuyler Electric Light Co., of New York.

336,203 Method of and apparatus for transmitting, reproducing, and recording speech; Chichester A. Bell, Washington, D. C.

336,268 Telephone transmitter; Henry S. Thornberry, Boston, Mass., assignor to the American Bell Telephone Company, same place.

336,276 Insulator for telegraph wires; John Wilson, New York, N. Y.

336,284 Learner's telegraph instrument; Emmor Bonsall, Davenport, Iowa.

336,329 Mouthpiece for telephone transmitters; G. L. Lavery, East Boston, Mass,

336,352 Galvanic battery; Alexander H. Roovers, and Alfred W. Roovers, New York, and Percy G. Williams, Brooklyn, N. Y.

336,371 Skeleton tower for electric lights; John S. Adams, Detroit, Mich., assignor to the Detroit, Iron Tower Company, same place.

336,452 Electric arc-lamp; Chas. J. Van Depoele, Chicago, Ill.

336,453 Overhead conductor for electric railways; Charles J. Van Depoele, Chicago, Ill.

336,479 Speaking tube; Allen Fontaine, New York, N. Y.

336,503 Electric arc-light; Addison G. Waterhouse, Hartford, Conn.

336,510 Electric mouth and throat illuminator; Louis F. Criado, Brooklyn, assignor to Stout, Meadowcroft & Co., New York, N. Y.,

336,518 Magneto-electric door bell; William Humans, Cambridgeport, Mass., assignor to Gilman Collamore, Boston, Mass., and the American Magnetic Electric Company, Jersey City, N. J.

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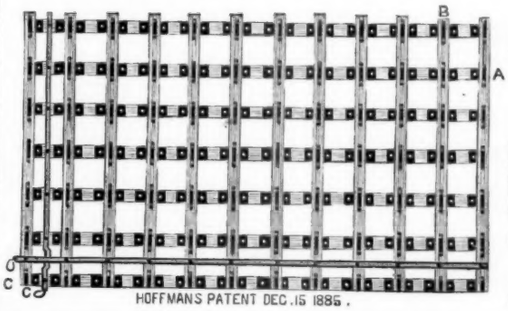

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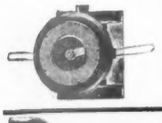

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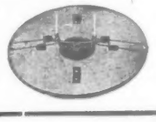

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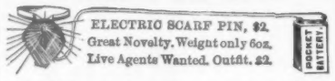

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Thomson & Houston, March 1, 1881, Current Regulator for Dynamo-Electric Machines, No. 238,315.

Elihu Thomson, Oct. 10, 1882, Regulator for Dynamo-Electric Machines, No. 265,937.

Elihu Thomson, Dec. 26, 1882, Regulator for Dynamo-Electric Machines, No. 269,606.

Elihu Thomson, Feb. 6, 1883, Electric Current Regulator, No. 271,948.

The above patents fully cover the principle and methods of automatically regulating the electric current without the use of variable resistances, and without waste and loss of power. By these inventions all irregularities in speed of engines are compensated for and any number of lights can be freely turned on or off at will without any attention to either dynamo or regulator. These advantages are possessed by no other system of electric lighting, and upon such advantages depend almost entirely the profits of local electric lighting companies.

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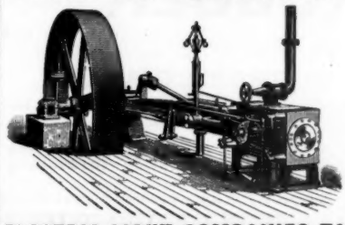

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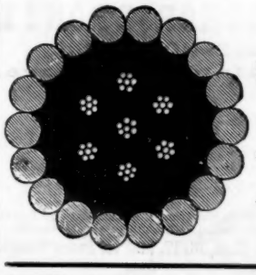

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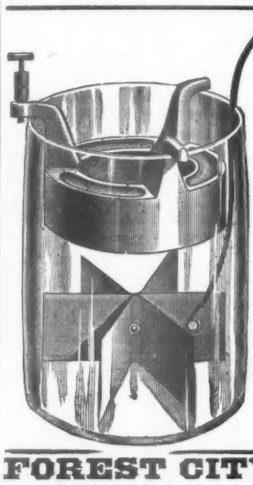

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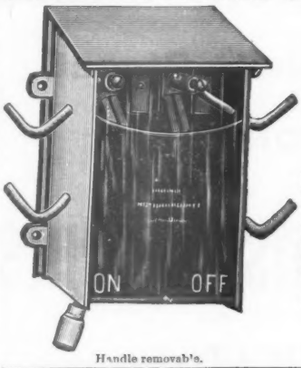

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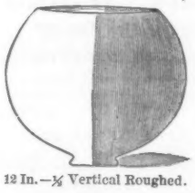
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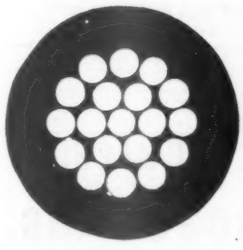

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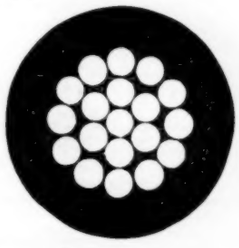

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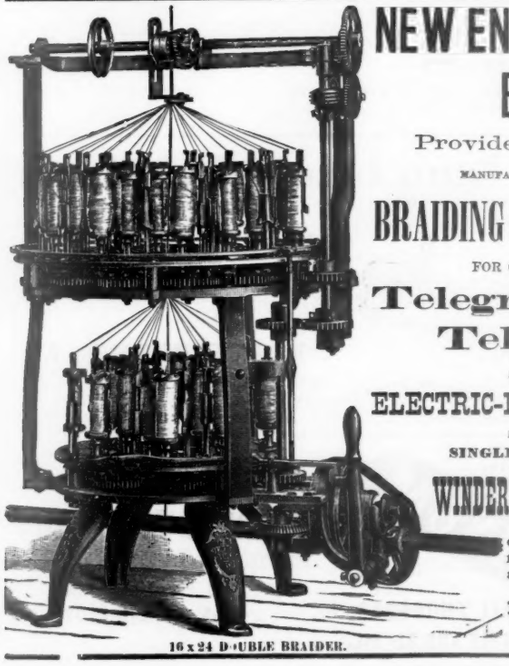

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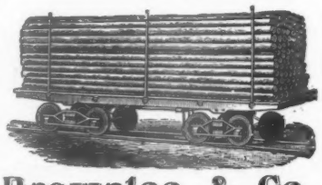

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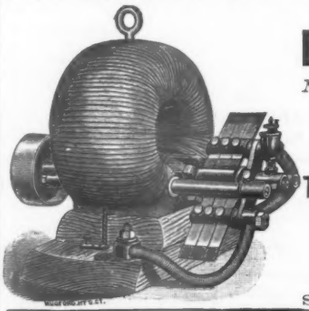

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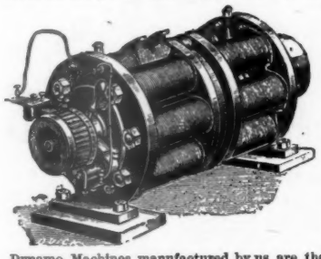

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